The Online Journal of Science and Technology

Volume 4 Issue 1
January 2014

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Message from the Editor-in-Chief

The Online Journal of Science and Technology has published first issue of 2014. I would like to wish you good knowledge sharing and brilliant professional activities in the New Year. In this respect, I am happy to put forward gaining success of presenting international researches by my team and enhancing quality in the academic agenda. It is crucial to make a bridge between researchers and as an editor-in-chief, I would like to thank readers, researchers and academicians whose support pay attention to our journal's development. The Online Journal of Science and Technology in Education has interdisciplinary researches. We are pleased to receive your qualified research papers for the next issues.

Prof. Dr. Aytekin İŞMAN

Editor-in-Chief of TOJSAT

Message from the Editor

Dear Readers,

Welcome to the 4th volume of TOJSAT journal which widely covers the scientific and technological developments of all areas. We would like to be a bridge between science and technology. Last year, we carried out Iste-c 2013 conference held in Dubai, United Arab Emirates and selected papers were accepted to publish in this journal after a rewieving process.

I thank to the readers all around the World for supports by sending their valuable scientific works to publish in the journal.

Prof. Dr. M. Şahin DÜNDAR

Editor, TOJSAT

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A Framework for the Participatory Design of Interactive Media Façade

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Abstract: Media facade is considered as one major trend in designing building skin. The Interaction modes of media façade are categorized into three classes one-way, reactive, and interactive. Interactive media facade as a public display possesses a great social potential to interact with citizen. There are two approaches to participatory design by citizen: 1) for implementation of the facade is 'design process' to participate, 2) dynamic creation of media contents. This page focused on the creation of content especially interested in the method of contents operation design. We analyze previous cases to propose as framework of designing participatory in media façade. Also examine these cases understanding characteristics and then recognize effectiveness, and significances. In conclusion we provide a conceptual framework to contents design operation and use the framework presented here to draw a method for cooperation and coexistence of citizen.

 Keywords: Participatory design, Media façade, Public display, Community interaction

Introduction

In contemporary architecture, media façades are considered as one major trend of building skin design. The building skin not only separates the inner from the outer space, but performs more extensive functions such as an independent subject which express concepts of modern architecture. Applying digital media technology to the building skin creates a media façade through which the skin can change and communicate with its surroundings. The interaction modes of media façade are categorized into three classes: one-way, reactive, and interactive. Interactive media façades are public displays with strong potential for citizen interaction. Large urban displays allow the simultaneous association of many people with the installation, thereby exerting affirmative effects on social engagement and co-presence in front of the façade (Fischer and Hornecker, 2012). Recently, researchers have recognized the potential of media facades to be seen or designed by numerous individuals simultaneously (Schoch, 2006, Seitinger *et al.*, 2009). Especially, interactivity scenarios can be designed for collaborative multiusers (Boring *et al.*, 2011). Media facades function as public displays that create a novel local communication media. Ultimately, these displays promote community interactions and intensify an awareness of location (Memarovic *et al.*, 2012).

Citizens can participate in media façade design in two ways: through "design process" or through "contents creation," where participants offer contents. The current study focuses on the design of content creation. To realize such a participatory design, continuous activity, rather than a solitary reaction, must be ensured by "inducement of voluntary participation." Therefore, we propose a methodology for continuous engagement that promotes public interests. To this end, we concatenate shared community issues, common goals, and local problems, and apply them to community development and social network promotion. We allow individuals to perceive their own problems and participate in resolution. The proposed design framework for media façade participation is developed from previous case studies. By understanding the characteristics of these cases, we can realize their effectiveness and significance. From the results of this analysis, we propose a conceptual framework of content design operation. Finally, we develop a method that encourages cooperation and coexistence of citizens.

Case Analysis

This section presents case analyses of voluntary participation in prominent installations. Through these cases, we explore inherent social interactions and communication methods. In each case, we analyze voluntary participation and motivation to enable self-activity. The results are used to develop a framework in the next section. The selected cases involve distinctive participation through multiuser interactive media façades in urban settings.

The interaction method is analyzed in terms of "levels of social interaction" presented by Ludvisen (2005). Ludvisen's framework is based on Goffman's concepts of behavior in public spaces (1963), namely occasion, situation, and encounters. Social interaction occurs at four levels: distributed attention, shared focus, dialogue, and collective action. Distributed attention occurs at the level of individuals, the "bubble" state in which passers' by do not interact. During shared focus, several individuals observe and explore the same item. Dialogue occurs when individuals share their opinions and explore intensively. In collective action, individuals engage and work toward a shared goal. This form of interaction is observed in choreography and mass explorations. In Table 1, each case is mapped to an appropriate level of social interaction.

Table 1: Mapping of cases to "levels of social interaction"

Level	Karckrona2 (Karlskrona, 1999)	Face Your World (Columbus, 2002)	D-Tower (Doetinchem, 2004)	BBC world channel, Time Square (New York, 2007)	Aarhus by Light (Aarhus, 2008)
Distributed attention				●	●
Shared focus		●		○	●
Dialogue	○	●	●	●	
Collective action	●		○		

○ Partly relevant   ● Directly relevant

Although Ludvigsen's social interaction model is of limited use as a conceptual framework, it provides a useful scale of engagement. The different interaction levels reflect participants' attention levels to situations, which are related to behavioral patterns. Consequently, this conceptual social interaction framework can be related to socio–cultural behaviors through the scale of engagement. Table 1 places each case within an equivalent socio–cultural category.

Participatory interactive media façades engage individuals at the uppermost social interaction level. As shown in Table 1, Karlskrona2 and D-Tower have achieved collective action. In particular, Karlskrona2 is programmed to engage citizens as virtual decision makers, permitting them to discuss and negotiate city development schemes. D-Tower informs the urban community about "feelings of the city" through a questionnaire on the D-Tower website. Various capsules allow individuals to state their impressions of the tower, and the most active participants receive a gift for their efforts. The tower enhances community intimacy by building emotional communion.

As shown in Table 2, "voluntary participation inducement" is a primary characteristic of participatory interactive media façades. To analyze voluntary participation, we should understand the purposes and provisions that inspire motivation. Therefore, we analyze the cases in terms of motivation, purpose, participation methods, and urban values.

Table 2: Cases analysis – concentrated upon the participation properties

		Karlskrona2 (Karlskrona, 1999)	Face Your World (Columbus, 2002)	D-Tower (Doetinchem, 2004)	BBC world channel, Time Square (New York, 2007)	Aarhus by Light (Aarhus, 2008)
Image						
Voluntary participation	Motive	Participating in decision making for their community	Redesign of their community	Expression of community feelings	Willingness to polling	Their silhouettes displayed on the facade
	Goal	Social community network	Interaction for the engagement in their local community	Social community network	Social community network	Entertainment
Reflecting local contents		High	High	Mid	Low	Low
Expression type		3D virtual model	Image	Colours	Picture and number	Moving silhouette image
Participation method		Internet	'Multiuser computer Game' equipment	Internet	Cell phone	Movements or Gestures
Value		Community reflection Mediation	Social Entertainment	Sense of community	Exchange of views	Playfulness Eye-catching

Among the analyzed cases, Karlskrona2 and Face Your World are characterized by sufficient community contents. Thus, they are inherently more likely to inspire motivation than Aarhus by Light and BBC World Channel. The motivation is provided by specific community actions that enable community development beyond superficial interests.

In conclusion, participatory interactive façades are moving toward socio–cultural relationships, where individuals cooperate to achieve a shared goal. Cases that achieve this level of engagement place high value on community concerns and encourage voluntary participation within the community.

Conceptual Framework

Participatory design can be perceived in two ways. First, collaborative creation, in which users intervene in the design decision-making "process" to arrive at a final completion. Second, using phase, in which persons are permitted to produce open-ended contents. In other words, users do not work toward an end goal in this form of participation. In this study, we are especially interested in designing a participatory using phase that allows users to engage in content provision and operation. In the public space, while individuals are socially connected through various media platforms, few interactive media façades are available for facilitating social interactions. The main barrier to interactive media façade development is the embedding of socio–cultural fabric into urban spaces (Brynskov *et al.*, 2009). As revealed by the case analysis, methods that apply local contents and pursue community goals can attract active participation. Thus, we propose a method that facilitates social interaction by promoting public interests. In community welfare studies, the community is the hub of individual or group activities. Personal matters are regarded as communal problems that can be solved through cooperation of residents and experts. In addition,

participation of citizens as the main agents of community welfare is important not only in professional manpower (Park, 2012).

According to Benkler, by focusing on content creation, individuals gain the psychological satisfaction of connecting with each other by creating contents. He regards social and psychological desire as a component of "motive structure." If a social production satisfies the participants' "motive structure," it will be perceived as pleasurable even when it is challenging (Benkler, 2006). Therefore, one role of a media façade is to mediate social and psychological interactions with people and community welfare. The main elements of our framework are the individuals within the community, the interactive media façade, and its contents (Figure 1).
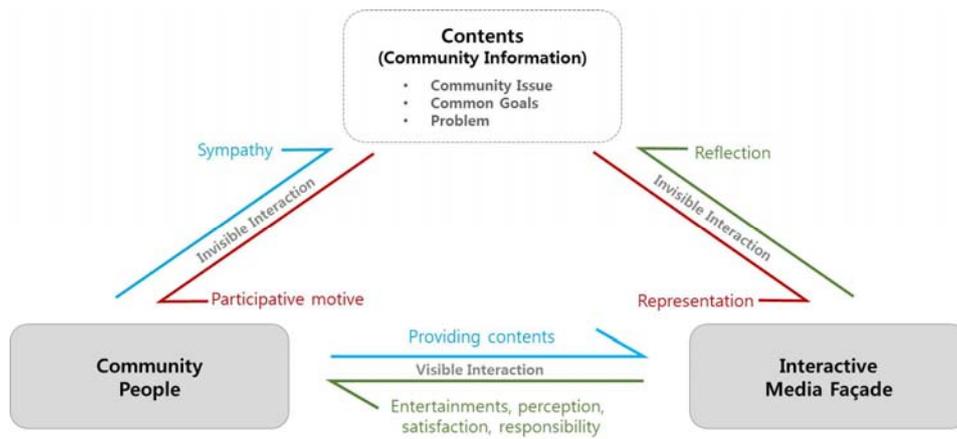
Figure 1: Interaction among the three main elements of the proposed framework

Each element links to other elements through visible and invisible interactions. Visible interactions occur between community people and the interactive media façade. While individuals transmit shared content through a device, façades send information by large displays. On the other hand, community contents are characterized by shared community issues, common goals, and problems that serve as invisible interactions between people and media façade. Figure 2 illustrates the intrinsic meanings underlying the streams of content between people and façade.
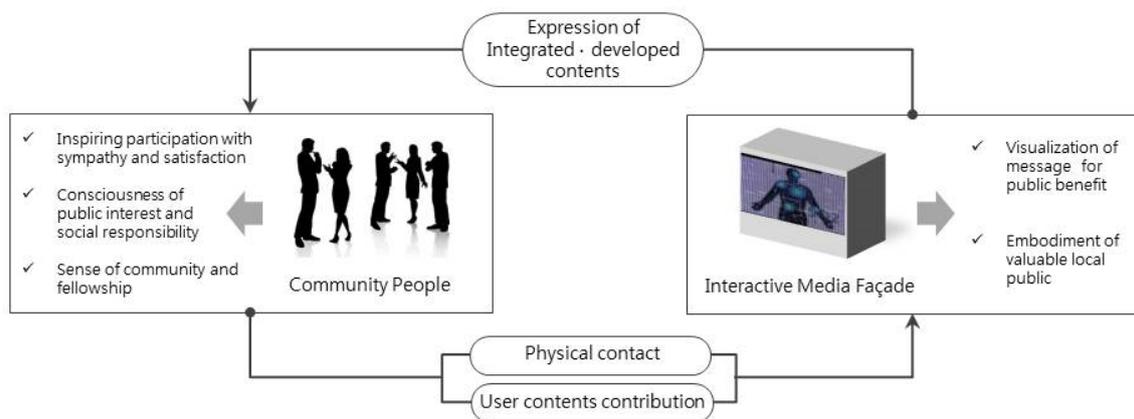
Figure 2: Relationship focused on intrinsic meaning

The media façade integrates and develops content provided by individuals into a visual display that embodies a valuable local public campaign. Individuals who encounter the worked content develop empathetic and satisfied feelings. They develop an awareness of responsibility, community belonging, and fellowship.

The methods through which people transfer contents can be variously designed, but are broadly classified into two large groups. One is physical contact with a previously installed object, which makes it possible interacting to lead human behaviors. The user benefits from an enhanced experience because an offline taction is added to online visualization. The latter embraces the easy dissemination of sketch, voice, picture, graffiti text, and behavior. Interactive media façades reorganize and integrate these methods to provide contents.

A multicultural family scenario

Target community

Ansan City in Korea is characterized by a high density of small- to medium-sized manufacturing firms. The number of immigrant workers is significantly higher than that in other Korean cities. In the Wongok district, the ratio of foreigners to natives is nearly 40 percent. Therefore, the Ansan municipality endeavors to embrace foreign cultures through measures such as special multicultural zone designation and establishment of community centers. However, in daily life, regardless of welfare assistance, children of multicultural families feel alienated from their classmates. They may be victimized by native children for various reasons such as language, nationality, and skin color. In addition, they may not adjust to school life or may leave school altogether. Because children tend to be intolerant of other cultures, immigrant children may experience lack of consideration and confused identity, besides being influenced by parental bias and the media.

Native residents are becoming increasingly cognizant of community problems associated with rapid influx of foreigners (Lee, 2008). Thus, our scenario aims to improve cultural awareness among native residents. The scenario comprises the three main elements discussed in the previous section: multiuser, media façade, and contents (Figure 3).
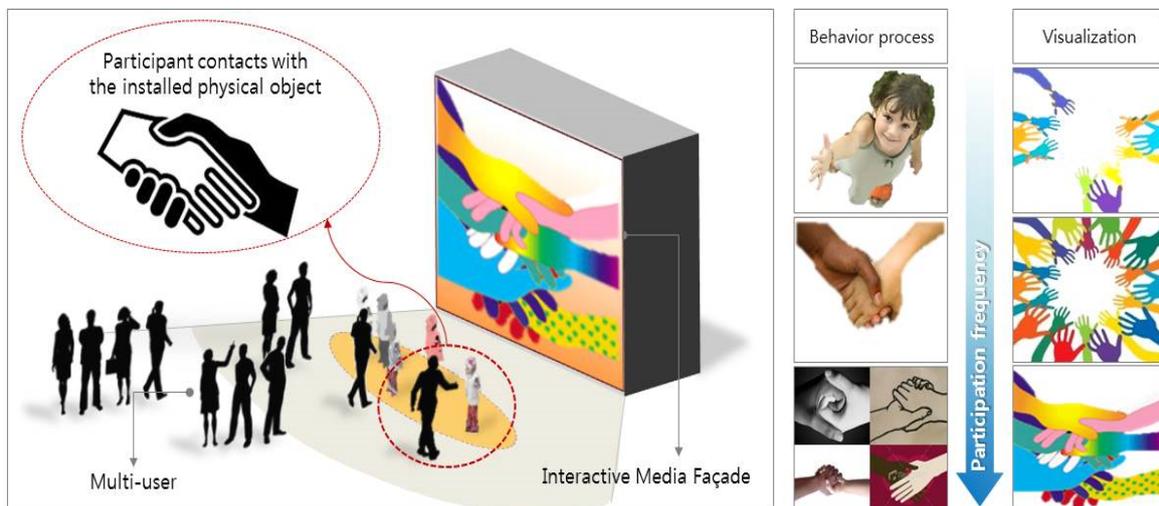
Figure 3: A scenario based on a multicultural family framework

Visible interaction between multiuser and interactive media façade

Providing contents by touch enhances the sensory experience. For example, a sense of "body temperature" is synonymous with "warmth - person in need of attention." Installed physical objects, such as a temperature sensor attached to the hand, can supplement descriptions of children of multicultural families. When participants contact the objects, information about both body temperature and visual display is conveyed in virtual space. As a multiuser interaction mode, visualization is pertinent to achieve by accumulating the participation of multiple individuals.

Content-based invisible interaction

Media façades integrate and develop the contents provided by users. Such integration and development can be used to improve awareness of and reduce bias against multicultural families. In his book "Knowledge and Human Interest," Jurgen Habermas posits that cognition and practice behavior are interrelated (Habermas, 1972). Since experience can build cognition, we expose the user to situations and renewed perceptions. This scenario seeks to change user perception by the following sequence of phased experiences.

- 1st experience: Touch-induced behavior design → forming emotional familiarity rather than seeing
- 2nd experience: dynamic experience of screen changing; the façade can influence action(touch) → arouse user's interest by interaction of façade
- 3rd experience: perception that visualization can truly assist other community members.
- 4th experience: users gain satisfaction from realizing that their voluntary participation has assisted a neighbor → encouragement effect by feedback

Similar to the previous case analysis, Table 3 summarizes the participation properties of the proposed scenario. The user is motivated to participate by contacting a physical object such as a human hand. The goal of participation is to assist others within the same community, specifically, to facilitate a positive attitude toward multicultural families. Finally, this participation seeks to change intrinsic social attitudes toward multicultural families.

Table 3: Participation properties of the proposed scenario

Social interaction level		Collective action
Voluntary participation	Motive	Behavior affordance
	Goal	Helping hand for the community people
Reflecting local contents		High – Local problem recognition
Expression type		Visualization of the cumulative participation frequency
Participation method		Holding hands of physical objects in children shape
Value		Change in participants perception

Conclusions

As novel mediators of urban communication, the social potential of media facades is vast. Interactive media façades encourage interactivity between people and buildings, forming events in urban space, and promoting awareness. Media façades also disseminate entertainment and real-time activity, and encourage two-way relationships. Therefore, as mentioned above, media façades are currently regarded as a prominent social medium.

We have defined a conceptual framework for interactive media façades, on the basis of user participation. The real-world applicability of the proposed framework was illustrated by introducing a community scenario. This study aimed to investigate content provision by user participation. The framework was inspired by previous reports on social interaction levels and voluntary participation. From the analysis, we identified effectiveness and reorganized significance as important outcomes. Continuous voluntary participation is rendered possible by involving community contents in the media façade design and by configuring socio–cultural relationships as a collective action. In conclusion, our method facilitates social interactions through voluntary participation by community members who post contents or pursue common goals. The elements of the framework are people, interactive media façade, and community contents. The contents include people-related issues and local problems. The framework also conveys intrinsic meaning among the elements. By applying the framework to a timely scenario, we attempted to describe real-world content streams and relationships among the main elements. Although the proposed framework and scenario are constrained by the conceptual form, the framework will contribute to community enlightenment and will integrate social contents into various types of media façades.

Acknowledgements

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Carbon Emission Based Optimisaton Approach for the Facility Location Problem

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Abstract: In today's global competitive economy, companies should create value for customer and create value for environment to protect their competitive strengths and/or obtain competitive advantages. Creation of value depends on developing strategic approaches like determining carbon emission level to consider environmental effects. Furthermore, the financial incentives and governmental pressures on companies to reduce their emissions force companies to change and optimize their internal and external processes in order to reduce their greenhouse gas emissions.

In this paper, a carbon emission based facility location problem is discussed. A new hyrid method that aims to reduce the amount of CO_2 emission in distribution network is presented. Fuzzy C-Means and Gustafson-Kessel algorithms are used to perform clustering analyses. This is followed by the selection of appropriate facility location through the minimization of CO_2 emission levels resulting from transportation activities between the facilities and customers by using the emission based center of gravity method which is a new method developed from classical center of gravity method

Keywords: Green logistics, carbon emission, multiple facility location problems, fuzzy clustering, center of gravity.

Introduction

Parallel to the economic and technological developments, the destruction and deterioration of environmental assets along with the inability of developed societies to find solutions to the global problems such as famine, starvation, greenhouse effects etc. and the uncertainty with respect to the future of human kind (McMichael et al., 2006) has increased the awareness on environmental issues particularly in the second half of the 20th century while bringing up the concept of environmental management. In spite of the legislative reforms, changes in customer demands and inline with the international certification standards, various companies operating in different sectors have started furnishing services and manufacturing products as well as providing after-sales customer care from an environmentally conscious standpoint. In this regard, they started focusing on creating ecological assets taking up a sense of social responsibility and recently green policies have become more popular than ever.

Within the literature environmental consciousness as a general approach has become the center of attention for many disciplines, while modern logistics and supply chain management disciplines also started taking environmental issues into account. The impacts of environmental issues on several logistics decisions such as facility, warehouse and distribution centers locations or raw material sources determination, distribution types and network selection, are especially evident (Wu and Dunn, 1995).

The facility location problem has strategic significance for logistics network design (Harris et al., 2009). The term "location problem" depends on the modeling, formulation and solution of a group of problems related to locating facilities in a given space. Until today the models for facility location were used in various applications. The difference between these models emanated from the type of function, distance measurement value used, the number and the size of the sites to be established and many other variables that required decision-making (Farahani and Hekmatfar, 2009).

In general, it is possible to classify the facility location models according to the structure of the physical region as continuous, discrete and network-based models. In continuous models, the facilities can be located at any point within the multidimensional space while in discrete models; the location of the facility is selected from the pre-determined alternative location groups (Sule, 2001).

With regards to facility location problem, the type of the objective function is usually the cost minimization function. In the cost function, the total cost is expressed as the sum of all distribution costs and fixed costs. In addition to this, other objects used within the facility location problems include: institutional expenses, total annual transaction costs, average time/distance covered, minimization of variables such as the number of facilities located and maximization of facilities that are provided with services and responses.

Recently the environmental and social objectives that rely on issues such as costs related to energy and structure as well as pollution, noise, quality of life, fossil fuel crisis have all become significant for facility location problems (Farahani et al., 2010). Specifically the decisions related to the determination of the optimum number and location of services in the process of redesigning the logistic networks and these are directly related to the impacts of greenhouse effects are taken into account when realizing environmental objectives (Harris et al., 2011). However, the question of formulizing an critical environmental issue such as the carbon emission that comes up as a result of logistic activities is still among the challenges frequently discussed. The optimization methods that include carbon emission are increasing gradually in recent years.

Yurimoto and Katayama (2002) developed an algorithm for obtaining the optimal number and locations of public distribution centers in Tokyo with the aim of reducing the amount of truck CO_2 emissions while minimizing logistics costs. Ramudhin et al. (2008) introduced a mixed integer mathematical model formulation for the "Carbon-Market Sensitive - Green Supply Chain Network Design" problem and they provided decision makers to understand the trade-offs between total logistics costs and the impact of greenhouse gases reduction. Li et al. (2008) propose a bi-objective mathematical programming methodology, which aims to maximize the profits of the supply chain and to minimize the carbon emission of the supply chain while optimizing distribution center locations. They investigate the impact of crude oil price changes on location decisions. Pan et al. (2009) explored the effect of merging supply chains on reducing CO_2 emissions from transport with two possible modes, road and rail and showed that the logistical mutualisation is an efficient approach to reducing CO_2 emissions. Diabat and Simchi-Levi (2009) presented a novel optimization model for green supply chain management that integrates a mixed-integer programming model with carbon emission considerations. Govindan and Kannan (2010) developed a bi-objective model to minimize the cost function and energy consumption for a reverse logistic network design. Iakovou et al. (2010) provided a strategic decision methodological framework that identifies the optimal mixture of offshoring/nearshoring policy, while capturing quantitatively free trade and sustainability related parameters. Xiaoli et al. (2010) suggested a model of distribution centers location decision based on minimizing the carbon emissions of logistics. Based on this model, genetic algorithm was used to optimize the locations of distribution centers. Paksoy et al. (2011) proposed a multi objective mathematical model to solve the closed-loop supply chain problem for the green impacts and focused to minimize total CO_2 emissions. Wang et al. (2011) introduced a green supply chain network design model, which consider of environmental element that includes environmental level of the facility and environmental influence in the handling and transportation process. Bouzembrak et al. (2011) considered two objective functions with their multiobjective optimization model, which were total cost and total CO_2 emission in all the supply chain. Santibanez-Gonzalez et al. (2011) introduced mixed-integer 0-1 model for solving sustainable supply chain network design problem in public sector. The model involved inputs for reducing the greenhouse gas emissions produced by the transportation and the operation of the facilities and solved using a genetic algorithm. Shaw et al. (2012) proposed a model that embodied carbon footprint of the raw material and trade credit amount over the purchased item in the design phase of the sustainable supply chain. They used multi-objective goal programming to optimize total cost, total direct carbon emission, total indirect emission in a supply chain by considering different types of trucks having different emission level.

This study examines the question of facility location by applying it in the distribution network of a company in Turkey with a view to minimization of CO_2 emission levels and therefore looks into the new green logistics approach in Turkey. The remainder of the study is organized as follows: In the next section, the methods used in the study are discussed analyses. Fuzzy C-Means and Gustafson-Kessel algorithms are used to perform clustering analyses. This is followed by the selection of appropriate facility location through the minimization of CO_2 emission levels resulting from transportation activities among the facilities and customers by using the proposed emission

based center of gravity method. Results and detailed discussion of the case study are presented in the third and fourth parts respectively. Finally in the last section, the conclusions are thoroughly discussed.

Materials and Method

This study considers the facility location problem as part of the supply chain management cases and takes up a different perspective to develop a new optimization method based on carbon emission.

This new method, which does not yet exist within the literature, aims to minimize the CO_2 emission levels which come out in the supply chain distribution networks by pairing the demand points with facilities. The supply chain that is considered as part of this study includes the assignment of several demand points with two or more facilities in a geographical region. During the distribution activities among these facilities and demand points, CO_2 emission emanates. The facility locations are determined in accordance with the objective of minimizing this CO_2 emission.

This method is developed as two steps and during the first step the demand points are clustered into the pre-determined number of groups depending on their geographic coordinates through the fuzzy clustering analysis methods. Following this, in the second step each group is considered as a single facility location problem within itself and the optimum facility location is selected by carbon emission based center of gravity method, which is presented here first.

Fuzzy Clustering Analysis

Organizing objects among themselves according to their similarities is called clustering analysis. These analyses form clusters of those objects that similar to each other more than the others (Jain et al., 1999).

The clusters formed within clustering analyses can be regarded as a subset of the data group. The clustering methods can be determined as crisp or fuzzy depending upon the data assigns to these subsets.

Fuzzy clustering analysis is an unsupervised method and allows the clustering of data points according to their membership degrees between 0 and 1. This provides the flexibility for data points to be expressed as belonging to more than one cluster. Thus these membership degrees would lead to better grading of the details of the data model (Döring et al., 2006).

Fuzzy C-Means (FCM) Algorithm

Fuzzy C-Means clustering algorithm is the most common partitioned clustering technique and is founded upon the minimization of an end function named as C-Means function (Bezdek and Dunn, 1975). This algorithm was first proposed by Dunn in 1973 and further developed by Bezdek in 1981 (Höppner et al., 1999).

The FCM can be seen as the fuzzified version of the k-means algorithm and is based on the minimization of an objective function called c-means functional:

$$J(X; U; V) = \sum_{i=1}^{c} \sum_{k=1}^{N} (\mu_{ik})^m \|x_k - v_i\|_A^2 \tag{1}$$

Where A_i is a set of objects (data points) in the *i-th* cluster, v_i is the mean for that points over cluster i, $V = [v_1, v_2, \ldots, v_c]$, $v_i \in R^n$ is a vector of cluster prototypes (centers), which have to be determined, $D_{ikA}^2 = \|x_k - v_i\|_A^2 = (x_k - v_i)^T A(x_k - v_i)$ is a squared inner product distance norm and the $N \times c$ matrix $U = [\mu_{ik}]$ represents the fuzzy partitions, where μ_{ik} denotes the membership degree that the ith data point belongs to the kth cluster. Its conditions are given by:

$$\mu_{ij} \in [0,1], \forall_i, k, \sum_{k=1}^{c} \mu_{ik} = 1, \forall_i, 0 < \sum_{i=1}^{N} \mu_{ik} < N, \forall_k \tag{2}$$

FCM algorithm only can find clusters with the same shape and size because the distance norm A is not adaptive and it is often Euclidean norm (spherical clusters). The solution can be given by the lagrange multiplier method (Kenesei et.al., 2006)

Given the data set X which includes geographical X and Y coordinates, the number of clusters $1 < c < N$, the weighting exponent $m > 1$, the termination tolerance $\varepsilon > 0$ and the norm-inducing matrix A, the algorithm tracks the following steps (Balasko et.al., 2005).

Step 1: Compute the cluster prototypes (means):

$$V_i^{(l)} = \frac{\sum_{k=1}^{N}\left(\mu_{ik}^{(l-1)}\right)^m x_k}{\sum_{k=1}^{N}\left(\mu_{i,k}^{(l-1)}\right)^m} \qquad\qquad 1 \leq i \leq c \qquad\qquad (3)$$

Step 2: Compute the distances:

$$D_{ikA}^2 = (x_k - v_i)^T A(x_k - v_i) \qquad\qquad 1 \leq i \leq c, 1 \leq k \leq N \qquad\qquad (4)$$

Step 3: Update the partition matrix:

$$\mu_{i,k}^{(l)} = \frac{1}{\sum_{j=1}^{c}\left(D_{ikA}/d_{jk}\right)^{2/(m-1)}} \qquad\qquad (5)$$

This steps will be repeated for $l = 1,2,...$ until $\left\|U^{(l)} - U^{(l-1)}\right\| < \varepsilon$ where ε is the termination tolerance (Kucukdeniz et. al., 2012).

Modified Gustafson-Kessel (GK) Algorithm

Gustafson-Kessel algorithm is an extended state of the standard FCM algorithm (Kenesei et al., 2006). This algorithm was developed to detect different geometric shapes in a data set and uses Mahalanobis distance as the norm (Gustafson and Kesel, 1979; Esnaf and Küçükdeniz , 2009).

Gustafson-Kessel algorithm is based on an iterative optimization of the objective function of the c-means type (Babuska et al., 2002):

$$J(X; U, V, \{A_i\}) = \sum_{i=1}^{c}\sum_{k=1}^{N}(\mu_{ik})^m D_{ikA_i}^2 \qquad\qquad (6)$$

In equation (6), $U = [\mu_{ik}] \in [0,1]^{c \times N}$ is the fuzzy partition matrix of the data $X \in R^{n \times N}$, $V=[\ v_1, v_2 ,....., v_c]$, $v_i \in R^n$ is the cluster prototypes (means) vector and $m \in [1,\infty)$ is the parameter which determines the fuzziness of the resulting clusters. The distance norm D_{ikA_i} can take into account different geometric shapes in one data set and be calculated as follows:

$$D_{ikA}^2 = \|x_k - v_i\|_A^2 = (x_k - v_i)^T A(x_k - v_i) \qquad\qquad (7)$$

The size of each cluster is defined for the local Ai norm matrix that is used in the formula (6) as one of the optimization variables. This allows the distance norm to adapt to the local topological structure of the data. The minimization of the GK objective functional is achieved by using the alternating optimization method that is suggested by Gustafson Kessel (1979) as based on GK algorithm (Babuska et al., 2002).

In this clustering algorithm, data samples are small or data in a cluster are linearly related to each other, covariance matrix may become singular. To solve this problem in a simple and effective way, Babuska et al. (2002) modified the GK algorithm, as given in the following details:

For the given X data set, $c, m, \varepsilon, \rho_i$ standart parameters, β threshold numbers of conditions and γ weight parameter is chosen. Initial values of partition matrix are determined and covariance matrix F_0 is calculated for all data set.

Repeat for $l = 1,2, \ldots$

Step 1: Compute cluster prototypes (means):

$$V_i = \frac{\sum_{k=1}^{N} \left(\mu_{ik}^{(l-1)} \right)^m x_k}{\sum_{k=1}^{N} \left(\mu_{i,k}^{(l-1)} \right)^m} \qquad 1 \leq i \leq c \tag{8}$$

Step 2: Compute the cluster covariance matrices:

$$F_i^{(l)} = \frac{\sum_{k=1}^{N} \left(\mu_{ik}^{(l-1)} \right)^m \left(x_k - v_i^{(l)} \right) \left(x_k - v_i^{(l)} \right)^T}{\sum_{k=1}^{N} \left(\mu_{ik}^{(l-1)} \right)^m} \qquad 1 \leq i \leq c \tag{9}$$

Add a scaled identity matrix:

$$F_i = (1 - \gamma) F_i + \gamma (F_0)^{1/n} I \tag{10}$$

Extract eigenvalue λ_{ij} and Φ_{ij} from F_i
Find $\lambda_{i\,max} = maks_j \lambda_{ij}$ and set
$\lambda_{ij} = \lambda_{i\,max}/\beta \quad \forall j$ for which $\lambda_{i\,max}/\lambda_{ij} > \beta$

Reconstruct F_i by

$$F_i = [\Phi_{i1} \ldots \Phi_{in}] diag(\lambda_{i1}, \ldots, \lambda_{in}) [\Phi_{i1} \ldots \Phi_{in}]^{-1} \tag{11}$$

Step 3: Compute the distances:

$$D_{ikA_i}^2 = \left(x_k - v_i^{(l)} \right)^T \left[(\rho_i det(F_i))^{1/n} F_i^{-1} \right] \left(x_k - v_i^{(l)} \right) \tag{12}$$

$$1 \leq i \leq c \;,\; 1 \leq k \leq N$$

Step 4: Update the partition matrix:
For $1 \leq k \leq N$

If $D_{ikA_i} > 0$ for $1 \leq i \leq c$,

$$\mu_{i,k}^{(l)} = \frac{1}{\sum_{j=1}^{n} \left(D_{ikA_i}/D_{jkA_j} \right)^{2/(m-1)}} \tag{13}$$

Otherwise

$$\mu_{i,k}^{(l)} = 0 \text{ if } D_{ikA_i} > 0 \text{ and } \mu_{i,k}^{(l)} \in [0,1]$$

With $\sum_{i=1}^{K} \mu_{i,k}^{(l)} = 1$ otherwise.
Run on until $\left\| U^{(l)} - U^{(l-1)} \right\| < \varepsilon$ (Babuska et al., 2002)

The Center-of-Gravity Method

The center of gravity (COG) method tries to find the optimal solution for existing transportation facilities in a region, which gives the shortest paths. In the stage of finding this solution, significant activity areas are formulated. The aim of COG is to minimize the transportation costs either between customers and plants or between suppliers of raw materials and plants. The objective function and the basic parameters of the method are shown in equation (14) (Ballou, 1999):

$$MinTC = \sum_i V_i R_i d_i \qquad (14)$$

TC : Total cost (monetary unit)
i : demand (customer) or raw material (supplier) index
V_i : quantity or demand of goods at point i (tons)
d_i : distance of plant to demand point i (km)
R_i : Transportation cost to point i (monetary unit/km)

At the first stage of this method, gravity centers of each cluster are calculated by the following formulas;

$$\overline{X} = \frac{\sum_i V_i R_i X_i}{\sum_i V_i R_i} \qquad\qquad \overline{Y} = \frac{\sum_i V_i R_i Y_i}{\sum_i V_i R_i} \qquad (15)$$

Then again, d_i is recalculated with these values of the center of gravity.

$$d_i = \sqrt{\left(X_i - \overline{X}\right)^2 + \left(Y_i - \overline{Y}\right)^2} \qquad (16)$$

For the new $\overline{X}$ and $\overline{Y}$ coordinates, value of d_i is put in place in the following equation.

$$\overline{X} = \frac{\sum_i V_i R_i X_i / d_i}{\sum_i V_i R_i / d_i} \qquad\qquad \overline{Y} = \frac{\sum_i V_i R_i Y_i / d_i}{\sum_i V_i R_i / d_i} \qquad (17)$$

According to the latest coordinates, d_i is recalculated and iterations are continued until the difference between last two values of $\overline{X}$ and $\overline{Y}$ coordinates are lower than a specific threshold value.

Emission Based Center-of-Gravity Method

In this study, a new center of gravity method was developed by utilizing the center of gravity method that minimizes CO_2 emission instead of transportation costs. The aim of developed emission based center of gravity method is to locate facilities so that to minimize amounts of CO_2 emission that is the result of product transportation activities between production centers to demand points. Thus the environmental disadvantages can be reduced. Parameters and the objective function of this new method are shown in equation (18):

$$MinE = \sum_{\forall i \in C} d_i \times S_i \times ef_i \qquad (18)$$

E : Amount of emission (kg CO_2)
i : demand (customer) or raw material (supplier) index
C : cluster index
S_i : number of transports to demand point i
d_i : distance of plant to demand point i (km)
ef_i : Emission factor (kg CO_2/km)

As is evident from Equation (18), under a fixed emission-factor the amount of CO_2 emissions is proportional to traveled distance and the number of transportations. The emission factor used in the equation is determined

according to the type of vehicle. Due to the emission factor will vary according to the structure of the supply chain, when there is more than one type of transportation at the same time, this method can be used.

At the first stage of the emission-based center of gravity method, the center of each cluster is calculated in the following equation (19) by the emission factor and the number of transportation, which is demand connected variable:

$$\overline{X} = \frac{\sum_i S_i ef_i X_i}{\sum_i S_i ef_i} \qquad \overline{Y} = \frac{\sum_i S_i ef_i Y_i}{\sum_i S_i ef_i} \qquad (19)$$

Then, the distance value is calculated with Euclidean distance formula as shown in equation (20).

$$d_i = \sqrt{\left(X_i - \overline{X}\right)^2 + \left(Y_i - \overline{Y}\right)^2} \qquad (20)$$

After the value of d_i has been calculated, the value is put in place in equation (21) for new $\overline{X}$ and $\overline{Y}$ coordinates.

$$\overline{X} = \frac{\sum_i S_i ef_i X_i / d_i}{\sum_i S_i ef_i / d_i} \qquad \overline{Y} = \frac{\sum_i S_i ef_i Y_i / d_i}{\sum_i S_i ef_i / d_i} \qquad (21)$$

According to the latest coordinates, d_i recalculated and iterations are continued until the difference between last two values of $\overline{X}$ and $\overline{Y}$ coordinates are lower than a predetermined threshold value.

The emission factor is a standardized value determined according to road conditions, traffic density and vehicle type (motor structure, ignition energy, vehicle age). Emission factor used in this study and other emission factors depending on distance of different vehicles (in kilometers) used in road transport shown in Table 1 (WRI-WBCSD GHG Protocol_Mobile Combustion CO_2 Emissions Calculation Tool. January 2003. Version 1.2).

Table 1: Emission factor varies according to vehicle class, size and the type of fuel used.

Vehicle type	Fuel consumption	Activity Unit	Emission factor (kg CO_2/km)
Hybrid auto 56 mpg	4,2 l/100km	vehicle kilometers	0,1001
Small gas auto 29 mpg	8,1 l/100km	vehicle kilometers	0,1932
Medium gas auto 23 mpg	10,2 l/100km	vehicle kilometers	0,2436
Large gas auto 19 mpg	12,4 l/100km	vehicle kilometers	0,2949
LPG automobile		vehicle kilometers	0,1780
Diesel auto 24 mpg	9,8 l/100km	vehicle kilometers	0,2691
Gas light truck 14 mpg	16,8 l/100km	vehicle kilometers	0,4002
Gas heavy truck 6 mpg	39,2 l/100km	vehicle kilometers	0,9338
Diesel light truck 15 mpg	15,7 l/100km	vehicle kilometers	0,4305
Diesel heavy truck 7 mpg	33,6 l/100km	vehicle kilometers	0,9226
Light motorcycle 60 mpg	3,9 l/100km	vehicle kilometers	0,0934

*mpg: Miles per galloon (the values are determined by EPA_US)

Results

In this study, the data of Esnaf and Küçükdeniz (2009) are used. Esnaf and Küçükdeniz (2009) aimed to determine optimal facility locations and identify customers that will be assigned to the facilities for an asphalt company by minimizing transportation costs. They considered shipments of suppliers-to-facilities and facilities-to-customers while calculating transportation costs. They used the amount of demands and the coordinates of the demand points appeared both the European and Asian sides of Istanbul. In this study, only the data of 51 demand points (the coordinates of demand points and amounts of demand) on the European side are considered to minimize the amount of CO_2 emissions for the uncapacitated facility location problem. In application, three different numbers of clusters were tested. Moreover two different types of vehicles, which are diesel light truck and diesel heavy truck, were assigned randomly to these demand points.

In the first step, demand points in European side are clustered into 2, 3, and 4 clusters according to their geographic locations by using MATLAB 6.5 Fuzzy Toolbox (Balasko et al., 2005) for FCM and GK fuzzy clustering algorithms which are developed in. These clusters centers have been accepted as the initial locations of facilities for the following step. In the second step, the facility locations are recalculated using the proposed emission-based center of gravity method in order to minimize the amount of CO_2 emissions between demand points and facilities.

In the case study, the vehicles, which transport between customers and facilities, are diesel heavy truck with a capacity of 20 tons and diesel light truck with a capacity of 12 tons. Furthermore, the emission factors are taken as 0.9226 kg CO_2 / km for diesel heavy truck and 0.4305 kg CO_2 / km for diesel light truck. According to the five different random number set that assign trucks to demand points, X, Y coordinates for the facilities that are found with the emission-based center of gravity hybrid methods with FCM and GK clustering algorithms are shown in Table 2.

The amount of CO_2 emissions for the different methods, are shown in the Table 3:

The average amount of CO_2 emissions for the different methods, are shown in the Table 4:

Table 3: The amount of CO_2 emissions as a result of locating facilities directly to the cluster centers that are calculated by center of gravity or emission based center of gravity hybrid methods with FCM and GK algorithms

Number of clusters	Random number set	Total amount of CO_2 emission (ton CO_2)			
		FCM-COG	FCM-EBCOG hybrid method	GK-COG	GK-EBCOG hybrid method
2	1	818.061	810.316	1166.549	1164.958
	2	824.107	816.928	1179.072	1177.381
	3	820.327	812.357	1155.313	1153.357
	4	816.694	810.147	1174.668	1173.864
	5	824.681	818.751	1169.606	1169.401
3	1	718.227	713.524	748.215	741.099
	2	720.634	716.328	746.233	738.520
	3	701.761	699.353	750.016	741.643
	4	715.357	714.087	744.339	738.071
	5	723.339	722.753	746.916	740.309
4	1	624.890	618.598	747.590	743.566
	2	629.001	622.978	746.557	742.231
	3	612.144	605.693	744.638	742.138
	4	623.409	617.927	755.726	754.527
	5	626.554	621.794	759.967	759.295

Table 4: The average amount of CO_2 emissions as a result of locating facilities directly to the cluster centers that are calculated by center of gravity or emission based center of gravity hybrid methods with FCM and GK algorithms

Number of clusters	FCM-COG	FCM-EBCOG hybrid method	GK-COG	GK-EBCOG hybrid method
2	820.774	813.700	1169.042	1167.792
3	715.864	713.209	747.144	739.928
4	623.200	617.398	750.896	748.351

Table 2: Calculated *X* and *Y* coordinates of the cluster centers (facility locations)

Number of clusters	Random number set	(X, Y) coordinates found by FCM-EBCOG hybrid method		(X, Y) coordinates found by GK-EBCOG hybrid method	
		X	Y	X	Y
2	1	70.371	22.095	74.640	28.715
		36.604	34.504	62.430	21.418
	2	70.397	21.921	74.109	28.685
		36.656	34.575	62.649	21.003
	3	69.576	21.825	74.804	28.549
		36.882	34.755	61.341	21.170
	4	69.410	21.727	73.714	28.638
		36.882	34.755	62.753	21.325
	5	69.633	21.911	74.244	28.664
		36.882	34.755	62.195	21.365
3	1	73.159	22.114	70.223	21.229
		20.636	26.599	65.788	37.556
		49.807	25.164	36.882	34.755
	2	73.152	21.739	70.556	20.879
		20.636	26.599	65.736	37.728
		50.304	25.260	36.882	34.755
	3	73.051	22.019	69.662	21.434
		20.636	26.599	65.447	38.098
		51.322	24.203	36.882	34.755
	4	72.490	21.809	69.534	21.552
		20.636	26.599	65.785	37.535
		51.395	24.177	36.882	34.755
	5	72.866	22.250	69.353	21.702
		20.636	26.599	65.785	37.535
		51.615	24.366	36.882	34.755
4	1	74.366	21.962	61.311	37.491
		3.131	43.170	3.131	43.170
		58.431	22.730	73.250	21.744
		36.882	34.755	41.040	27.263
	2	73.977	21.439	61.209	37.896
		3.433	37.630	3.433	37.630
		57.803	22.775	73.223	21.355
		36.882	34.755	41.033	27.290
	3	74.341	21.846	60.903	38.506
		4.320	33.796	4.320	33.796

	57.475	22.615	73.155	21.642
	36.882	34.755	43.242	25.410
4	73.545	21.324	61.258	38.325
	3.685	35.069	3.685	35.069
	58.479	22.442	72.639	21.393
	36.882	34.755	43.290	25.358
5	74.206	21.945	61.307	37.659
	3.433	37.630	3.433	37.630
	58.639	22.575	73.021	21.860
	36.882	34.755	42.712	26.050

Conclusion

In this study, a new center of gravity method, which aims to minimize the amount of CO_2 emission with green supply chain approach, is developed. The new method is studied in sustainable supply chain management and applied to facility location problem. The method that is called as emission based center of gravity method states facility locations by minimizing the amount of CO_2 emission, which is the result of transportation between the demand points and facilities.

The proposed FCM-EBCOG hybrid method is benchmarked against FCM-COG, GK-COG and GK-EBCOG hybrid methods in five different sets. According to average of these results, FCM-EBCOG method outperforms all other methods in all sets of clusters.

FCM-EBCOG hybrid method gives 0.87%, 0,37% and 0,93% better total amount of CO_2 emissions results than FCM-COG method in two, three and four-clustered solutions, respectively. Similarly GK-EBCOG hybrid method achieves 0.11% lower results in two-clustered solution, 0.97% lower results in three-clustered solution and 0.34% lower results in four-clustered solution than GK-COG method.

If sustainable development is one of the most important subjects for companies, it must be also under debate for the facility location problem. Proposed emission based method helps to close the gap in this field.

In conclusion, in supply chain management applications that sustainability gains ground, carbon emission based methods should be developed. Methods developed with this concept will facilitate to minimize environmental damage of industrial applications as seen from this study. Therefore, this provides companies to operate globally in an ever environmentally conscious world.

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Compressive behaviour of glass fiber reinforced aluminium foam

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Abstract : The goal of this study was the analysis of the flatwise and edgewise compression response of closed-cell aluminium foam reinforced by the outer skins made of glass fiber reinforced epoxy matrix and the results were compared with those obtained for aluminium foams without glass fiber skins. Aluminium foams were produced by powder metallurgy method. Glass fiber skins were produced in various orientation angles in order to investigate their effects to the efficiency and capacity of absorbing energy of the sandwich. Glass fiber skins were bonded onto the aluminium foam core by epoxy resin in order to fabricate sandwich panels. As a result, the sandwich panels produced has particular importance for transport industries, such as automotive, aerospace, ship structures.

Keywords: Aluminium foam, powder metallurgy, transport application, sandwich panel

Introduction

Sandwich structures, consisting of glass fiber reinforced plastic (*GFRP*) skins bonded onto low density cores, offer great potential for use in various high performance composite structures which are nowadays widely used in transport industries (aerospace, marine, automobile, shipbuilding), defense because of their high specific stiffnesses and strengths, excellent thermal insulation, fire retardancy, ease of machining and forming among others. Most current sandwich structures are based on polymeric foams (such as *PVC*, *PUR*) and aluminium honeycomb bonded to *GFRP* skins. Recently a great number of metal foams have been developed to replace polymer foams in applications where multi-functionality is important. For instance, acting as a structural component in a sandwich composite but also as a fire retardant, acoustic damper or heat exchanger (Cantwell & Villanueva, 2004).

Several methods have been used to produce multifunctional metal foams. One of them is based on powder metallurgy technique. In this method, the precursor made by hot pressing or extrusion of metallic powder with foaming agent, usually TiH_2, is foamed by heating above the melting temperature of the material (Koza et al., 2003). The advantage of this method is the possibility to produce net shape lightweight parts. This makes these foams especially attractive for automotive, railway and aerospace industries, lifting and conveying systems because of their high capacity of absorbing energy (Yi et al., 2001, Ashby et al., 2000, p. 151-169, Banhart, 2001). As a new multi-function engineering material, aluminium foams *(AF)* have many useful properties such as low density, high stiffness, good impact resistance, high energy absorption capacity, easy to manufacture into complex shape, good erosion resistance, etc. [Banhart, 2001, Degischer & Kriszt, 2002]. This fact opens a wide range of potential applications for sandwich structures with aluminium foam core. As an example, aluminium foam sandwiches (*AFS*) (Ashby et al., 2000, p. 151-169, Gibson & Ashby, 1997), obtained by combining metal face sheets with a lightweight metal foam core, are suitable for applications in automotive industry and ship construction (Banhart et al., 1998), as they allow a speed increase with good passenger comfort, thanks to their specific weight and high damping capacity. The weight minimization influences the energy efficiency of the transport vehicles, reducing fuel consumption and environmental emissions and increasing payload carrying capacity and allowable speed. A design procedure for designing weight minimized hull structures for smaller high-speed craft was developed by Stenius et al. (Stenius et al., 2001).

Characterization of sandwich materials has been investigated in scientific literature. The specification of the sandwich material behaviour under crushing loads and the measurements of absorbing energy capacity and the ductile fracture limits is usually done by means of compression tests (Hayman et al., 2008, p. 417-427, ISO 844:2007, 2007). By this way, it has been understood that cores are the weakest part of sandwich structures and they fail due to shear.

The goal of the present research was the investigation of the flatwise and edgewise compression response of glass fiber reinforced aluminium foam (*GFR-AF*) and the comparison with the *AF* without *GFRP* outer skins in terms of absorbed energy. Primarily, aluminium foams were produced by powder metallurgy method using TiH_2 as foaming agent. Then, hand lay-up method was used to produce the outer skins, made of

glass fiber reinforced epoxy matrix, and the skins were bonded onto the both faces of *AF* using same epoxy which was used for the production of GFRP skins. The glass fiber reinforced skins can be easily bonded to the sandwich and it is possible to design the best configuration (base materials, fiber angle orientation, and number of layers) for a specific application. The flatwise and edgewise compression tests were carried out on *AF* and *GFR-AF* specimens by a universal test machine in order to compare and analyze influence of fiber orientation angles of *GFRP* to the efficiency and absorbing capacity of energy.

The obtained results have particular importance for applications that require multifunctional and lightweight structures with a high capacity of energy dissipation, such as the transport industry, where problems of collision and crash have increased in the last years.

Materials and Methods

The specimens were realized bonding two *GFRP* skins to *AF* cores using a commercial epoxy which was used for the production of outer skins (Fig. 1).

Figure 1. *GFR-AF* sandwich sample

The *GFR-AF* sandwich panels produced differ according to the fiber orientation types of *GFRP* skin material. Five different orientation types of outer skin have been investigated: first one $[0^{\circ}]_s$ with four layers, second one biaxial $[0^{\circ}/90^{\circ}]_s$ with four layers, third one biaxial $[45^{\circ}/-45^{\circ}]_s$ with four layers, fourth one symmetrically oriented$[0^{\circ}/90^{\circ}]_s/[45^{\circ}/-45^{\circ}]_s$ with two layers for each and the fifth one antisymmetrically oriented $[0^{\circ}/90^{\circ}]_s/[45^{\circ}/-45^{\circ}]_s$ with two layers for each. The physical and geometrical properties of the *GFR-AF* panels are reported in Table 1.

Table 1. Configuration and properties of the GFR-AF panels.

	Sequence	Number of layers	Material		Orientation Type	density	thickness
			GFR-AF for flatwise compression	GFR-AF for edgewise compression		[kg/m^3]	[mm]
Upper and Lower skin	1 and 3	4	Glass fiber and epoxy resin		$[0^{\circ}]_s$ $[0^{\circ}/90^{\circ}]_s$ $[45^{\circ}/-45^{\circ}]_s$ $[0^{\circ}/90^{\circ}]_s/[45^{\circ}/-45^{\circ}]_s$ symmetric $[0^{\circ}/90^{\circ}]_s/[45^{\circ}/-45^{\circ}]_s$ antisymmetric	1180	2.5
Core	2	1	Aluminium Foam		-	784	30

In the investigation, powder metallurgy method was used to produce aluminium foam cores. According to this method, primarily aluminium powders, with 44 microns, 99.7% purity and 99% of weight ratio, and foaming agent (TiH_2) powders, with 44 microns, 98% purity and 1% of weight ratio, were mixed using 3D mixer during 45 minutes in order to obtain homogenous mixture. Then, pressing at room temperature and 350 MPa pressure, extrusion at room temperature and under 350 MPa pressure and rolling after sintering of the material at 500 °C processes were performed respectively. And then, the specimens for compressive tests were sawed according to the dimensions given in ASTM standards and inserted into a mould which was made of steel. Finally, the specimens were separately foamed under 700ºC in a furnace observing of foaming process. After the foaming of a sample, it was cooled at room temperature.

Hand lay-up method was used to produce the outer skins, made of glass fiber reinforced epoxy matrix, and the skins were bonded onto the both faces of *AF* using same epoxy which was performed for the production of GFRP skins. According to the hand lay-up method, primarily the type and the number of the layers of the fibers were considered according to the dimensions of *AF* samples and the epoxy resin was prepared according to the mixture ratio given by the company. Then, a release agent was applied to the lay-up surface and finally glass fibers were laid up and impregnated with epoxy resin. It has been waited for about forty eight hours for curing of resin in order to produce *GFRP*. After curing, *GFRP* outer skins were bonded onto aluminium faces of *AF* using same epoxy in order to produce *GFR-AF* compressive test specimens. For curing of epoxy as an adhesive, it has been waited for about forty eight hours, too. All the production process of *GFR-AF* test specimens were schematically presented in Fig.2.
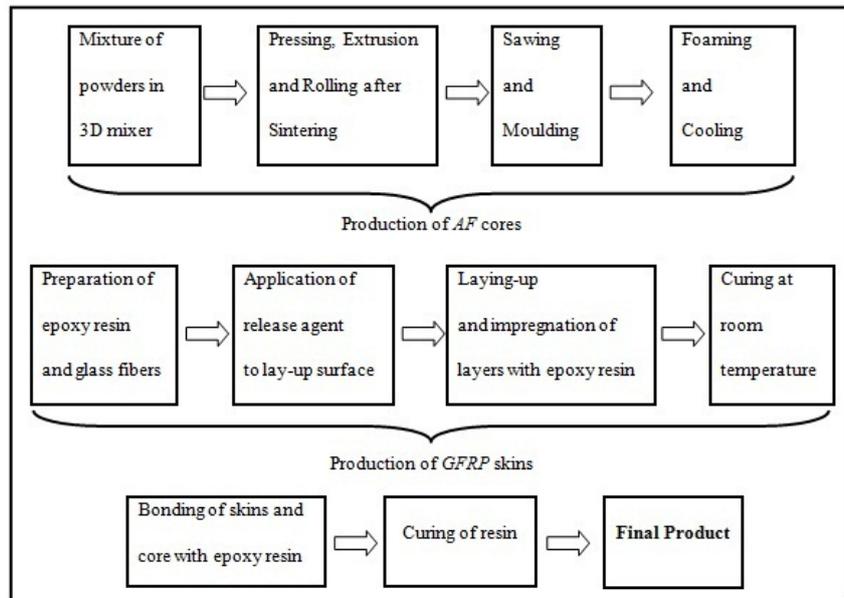
Figure 2. Illustration of production process of *GFR-AF* panels

The presence of the outer skins produces an increment of weight and thickness of about 1.3 and 1.2 times, respectively.

Experimental Investigation

Static flatwise and edgewise compression tests were performed on *AF* (30 x 30 x 30 mm) and *GFR-AF* panels (30 x 30 x 35 mm) with the presence of outer skins. The load was applied at a constant rate of 0.5 mm/min.
Figs. 3 and 4 show the stress-strain curves obtained under flatwise and edgewise compression tests.
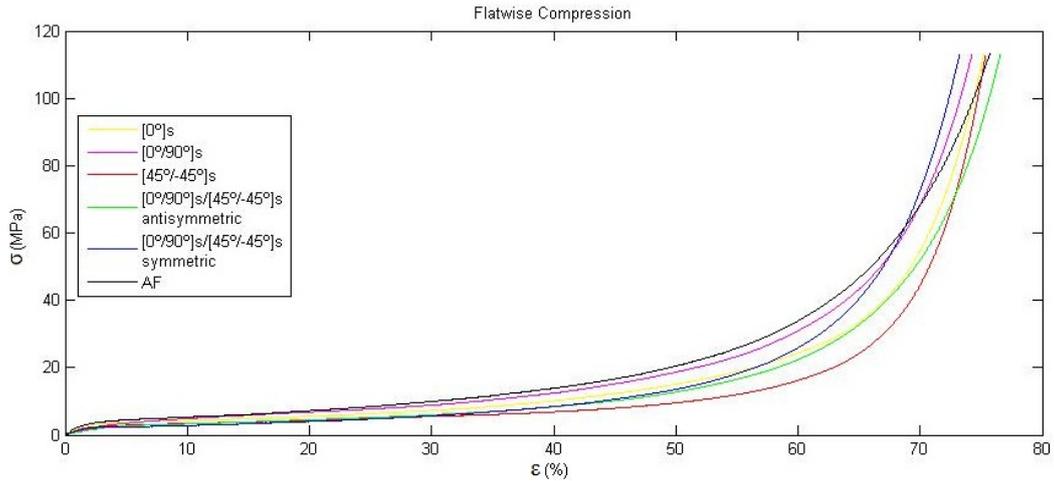
Figure 3. Stress-strain curves measured under static flatwise compression
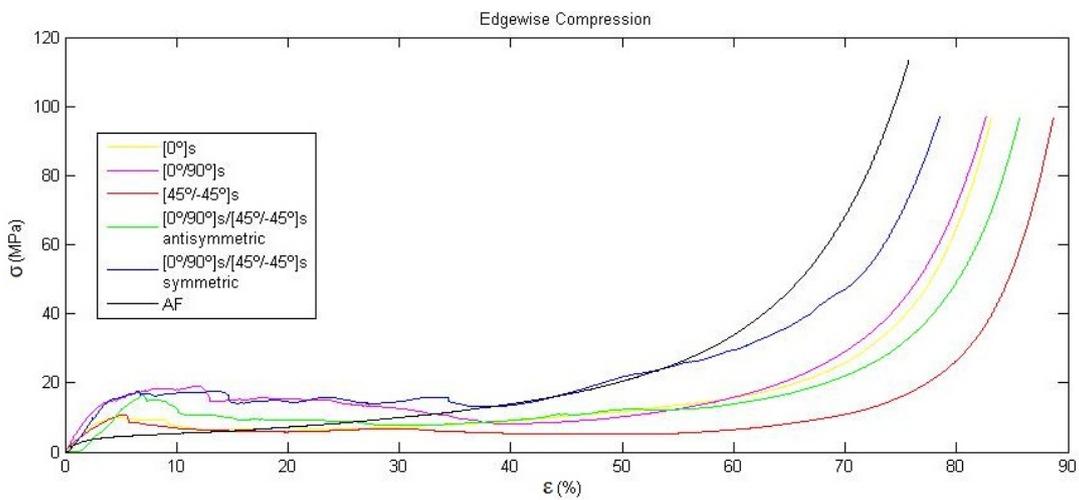
Figure 4. Stress-strain curves measured under static edgewise compression

From the Figs. 3 and 4, it is clear that all the panels exhibit an initial linear elastic behaviour, which is followed by a plateau region with an almost constant flow stress and afterward densification region starts with significantly increment of flow stress. During the flatwise compressive tests, the specimens were collapsed as core crushing and core shear while edgewise compressive specimens were collapsed as core shear and debonding and buckling of *GFRP* skins (Fig.5).
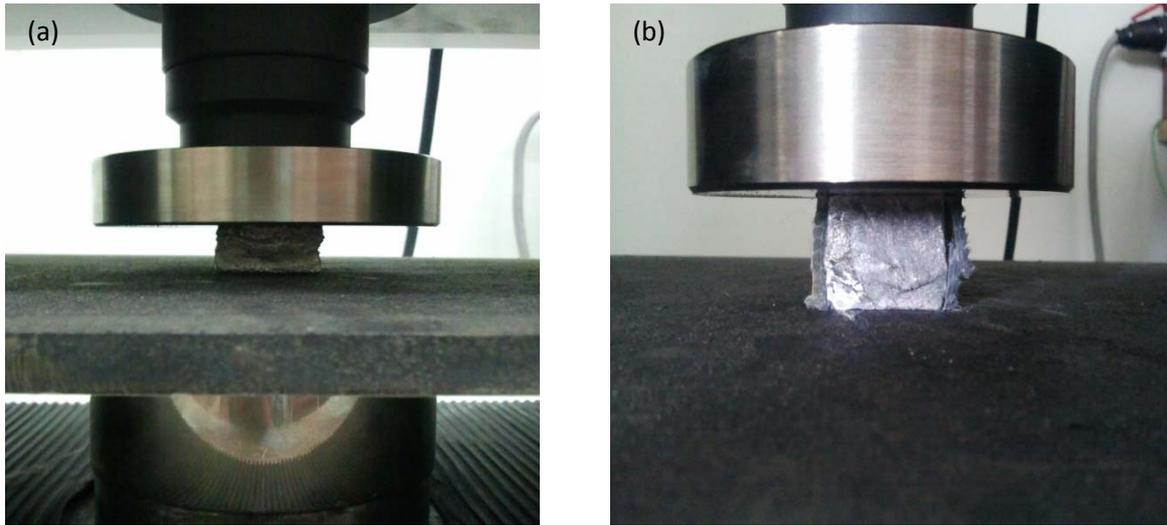
Fig. 5. Collapsed sandwich specimens during (a) flatwise compression with crushing and shear of the core (b) edgewise compression with crushing and shear of the core and debonding and buckling of facesheet.

When the sandwich specimen with foam core is subjected to compression test, the energy absorption capacity is defined as the energy required deforming a given specimen to a specific strain. That's why the energy absorbed per a unit volume of a sample, up to any given strain ε_0, can be evaluated by integrating the area under the stress-strain curve as given by the following expression:

$$E_{abs} = \int_0^{\varepsilon_0} \sigma(\varepsilon) \, d\varepsilon \qquad (1)$$

The energy absorption efficiency η is defined as the energy absorbed up to given strain divided by multiplication of this given strain and the corresponding stress.

$$\eta = \frac{1}{\sigma_0 \varepsilon_0} \int_0^{\varepsilon_0} \sigma \, d\varepsilon \qquad (2)$$

In Eqs. (1) and (2), ε_0 is the given strain, σ_0 is the corresponding compressive stress and σ is the compressive stress as the function of strain ε.

The maximum η during whole compression process and energy absorbed at certain strain are presented in Table 2. η_{max} and E_{abs} values are energy absorption efficiency and energy absorbed during compression at strain of 30% respectively.

Table 2. Energy absorption of samples under flatwise and edgewise compressive loading

		Flatwise Compression		Edgewise Compression	
		η_{max} [%]	E_{abs} [MJ.m^{-3}]	η_{max} [%]	E_{abs} [MJ.m^{-3}]
GFR-AF	$[0°]_s$	67	1.47	71	2.13
	$[0°/90°]_s$	63	1.68	77	4.42
	$[45°/-45°]_s$	69	1.14	70	1.98
	$[0°/90°]_s/[45°/-45°]_s$ symmetric	61	1.04	83	4.34
	$[0°/90°]_s/[45°/-45°]_s$ antisymmetric	64	1.15	74	2.80
AF	without skins	63	1.87	63	1.87

The results show that the effects of the configuration of the *GFRP* skin materials are not as significant as those on energy absorption capacity and energy absorption efficiency under flatwise compression. Configuration with $[0^{\circ}/90^{\circ}]_s$ and symmetrically oriented $[0^{\circ}/90^{\circ}]_s/[45^{\circ}/-45^{\circ}]_s$ show the largest energy absorption capacity and energy absorption efficiency among all orientations under edgewise compression in our study.

Conclusions

The investigation presented in this paper is a part of a larger project aimed at the introduction of lightweight structures, made of *GFR-AF* sandwiches, in transport industry (such as aerospace, automotive and shipbuilding industry).

The static flatwise and edgewise compressive responses of *AF* reinforced by *GFRP* outer skins were investigated and compared with those of *AF* without outer skins.

The experimental tests have demonstrated that the light-weight aluminium foams are efficient energy absorbers and the amount of energy absorption under edgewise compression tests can be improved up to about 2.5 times reinforcing them by means of *GFRP* outer skins which have various orientation angles although *AF* reinforced by *GFRP* skins under flatwise compression tests can not show effects as significant as those on the amount of energy absorption comparing them *AF* without outer skins.

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Linux, an Alternative Operating System Choice for Student

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Abstract: The objective of the study is to understand the operating system and how the cost licensing of the operating system becoming major issues. Open source operating system can be the alternative to reduce the cost of software licensing for the student and also others. The advancement of the Linux nowadays and it started replacing the user computer with the open source software. License/Commercial operating system software need to purchase for each of the computer and for upgrading to newer version the user required to purchase new license. Software piracy has becoming the trend to avoid purchasing the license/commercial software and these have becoming a plaque to the community.

Key words: Linux, Operating System, Open Source, Student, Cost.

Introduction

Shelly, Vermaat, Quasney, Sebok, & Freund (2012), an operating system is a set of programs that coordinates all the activities among computer hardware devices. It provides a means for users to communicate with the computer and other software. Many of today's computers use Microsoft's Windows. When a user starts a computer, portions of the operating system are copied into memory from the computer's hard disk. These parts of the operating system remain in memory while the computer is on.

According to Linux.org (2012), Linux is an operating system that developed from a kernel made by Linus Torvalds when he was a student at the University of Helsinki. He was using a version of the UNIX operating system called 'Minix', he and other users sent requests for modifications plus enhancements to Minix's creator, Andrew Tanenbaum, but the author felt that the request weren't necessary. That's the reason why Linus decided to develop his own operating system, developed in collaboration with other programmer that contributed the source code that would take into account users' comment and suggestions to improvements the operating system. Then operating system was later were introduced in late 1991 and known as Linux. Linux is an operating system means that it's intended to be used as an alternative to other operating systems for example Microsoft Windows, Mac OS, MS-DOS, Solaris and others operating system. Linux is not a program like a word processor and is not a set of software package like an office suite. Linux is an interface between computer/server hardware, and the programs which run on it.

Kirby (2000), stated that the Linux, the open source operating system originally developed by Linus. No Linux distribution is costly when equated to the price of licensing a commercial operating system. Linux runs on a wide range of hardware. In particular cases, Linux can allow old machine to install after it is no longer supported by the manufacturer. Due to its low resource requirements, Linux often can provide adequate performance on equipment that would be considered underpowered for use with commercial operating systems. Linux users appreciate a varied choice of application software. User interested in using Linux as a server can choose from a huge number of beneficial programs. A moderately underpowered PC running Linux makes a well Web server using Apache. Using SAMBA, a Linux system can function as a file plus print server for Macintosh and Windows clients/pc.

Linux Kernel

Corbet, Kroah-Hartman, McPherson (2012), the Linux kernel is the lowest level of software running on a Linux system. It is charged with managing the hardware, running user programs, and maintaining the overall security and integrity of the whole system. It is this kernel which, after its initial release by Linus Torvalds in 1991, jump-started the development of Linux as a whole. The Linux kernel keeps growing in size over time as more hardware is supported and new features are added.

The kernel which forms the core of the Linux system is the result of one of the largest cooperative software projects ever attempted. Regular 2 to 3 month releases deliver stable updates to Linux users, each with significant new features, added device support, and improved performance. The rate of change in the kernel is high and increasing, with between 8,000 and 12,000 patches going into each recent kernel release. These releases each contain the work of over 1,000 developers representing nearly 200 corporations. Since 2005, over 7,800 individual developers from almost 800 different companies have contributed to the kernel. The Linux kernel, thus, has become a common resource developed on a massive scale by companies which are fierce competitors in other areas.

Software Piracy and Open Source Software

Software piracy has seizure into a major problem for the software business. Software piracy violates existing copyright laws. Software developers protected by laws where unauthorized use and dissemination of copies of software without their authorization are illegal. Software piracy was considered to be acceptable and normative behaviour among college students. Major factor causing people to install pirated software because of cost and if given chance people choosing either originals or copies, they probably choose the pirated software because cheap and easy to get, Lau (2006) besides Kirby (2000) supported that cost is the most influence user in using commercial software licensing in their pc. Where by the software can purchase from the shop or just can be downloaded from the internet for free.

Software crack, the application code itself is reverse-engineered in order to recognize and reverse the copy protection methods in place. Copy protection systems for conventional desktop software can be complicated and intense to bypass. Key generator software emulates the software supplier's own user authentication system, allowing the illegal user to generate a serial number in order to register the software, Goode (2010). While the sensitive copy protection for retail versions can underwrite to the prestige associated with pirated software. So as to remove the copy protection, a cracker installs the software and then observers its process to define how it is deterring duplication. Cracked software is then packaged and uploaded to the group's private software servers. While other users then work to share the pirate software to other releases website.

Apart from that, Mutula & Kalaote, (2009) detailed that open source software is progressively seen as a good instrument because of its low cost compared with commercial software. Open source software refers to software that is free of proprietary restrictions and is developed, released and can be modified by the public for free of charge. The users of open source software are able to view the source code because source code given to the user, then alter the code and redistribute it. Installation of open source software is usually available to anyone without high priced license fees or other proprietary limitations. Open source software presents a good chance for the third world countries to move toward the information society by helping bridge the digital divide and deepening universal access. And open source software is not about cost, propaganda or taking business away from vendors rather it signifies the freedom to use the software for any purpose, freedom to study how the software works, freedom to modify the software to adapt it to one's needs, and freedom to copy and share copies of the software, with or without any changes one might make to it, Singh & Sanaman (2012).

This also supported by Free Software Foundation (2013, February 28) where define "Free software" means software that respects users' freedom and community. Roughly, the users have the freedom to run, copy, distribute, study, change and improve the software. With these freedoms, the users (both individually and collectively) control the program and what it does for them. When users don't control the program, the program controls the users. The developer controls the program, and through it controls the users. This nonfree or "proprietary" program is therefore an instrument of unjust power.

A program is free software if the program's users have the four essential freedoms:

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works and change it so it does your computing as you wish (freedom 1). Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbour (freedom 2).
- The freedom to distribute copies of your modified versions to others (freedom 3). By doing this you can give the whole community a chance to benefit from your changes. Access to the source code is a precondition for this.

Supported by Clay, C. (2012, January 31), a significant amount of money could be saved, if the business had switched to open source software when they had the opportunity. Proprietary and non-free products not only require a preliminary acquisition, and then often require re-purchasing upgrades at definite intervals, in order to stay compatible with the current hardware and/or Windows operating system. Open source Software are updated but still remain provided at no price to the community. Also Ziemer & Stenz (2012) believed that open source software is an alternative to commercial software. Successful open source projects have dynamic community that systematizes the group effort of users on the project's support and maintenance. Existing open source projects have proven that a community of users can develop large software systems.

Methodology

The objective of the study is to identify the students' problem when using commercial/license operating system and their awareness of Linux operating system as alternative. The benefit from the free/low cost of the operating system installed in their computer. The questionnaires were distributed via online using Google Drive Survey Form and totals 65 respondents' which are the second year student from Faculty of Information Management UiTM Sarawak. The survey was done from February 2013 to March 2013 and the respond were gathered and then analyse using PSPP, the open source software for data analysis.

Results

There are two methods that were used in the survey which are reliability and validity. Reliability is about the consistency of the measurement which is it refers to the consistency. Meanwhile, validity assesses whether the test measures what it claims to measure. In this survey, the instrument was tested for its validity and reliability. This is to ensure that the measures developed in the instrument were reasonably appropriate. The validation and reliability test conducted to ensure the instrument chosen is suitable and accurate. Cronbach's alpha determines the internal consistency or average correlation of items in a survey instrument to gauge its reliability. A reliability coefficient of .70 or higher is considered acceptable in most social science research situations and for this survey .822 for Cronbach's alpha. This disclosed that the items tested can be used for the research.

In Table 1 showing the gender of the respondent of the survey and female respondent were 39 respondents out of 65 of overall respondent.

Table 1: Respondent Gender

Gender	Respondent (65)	Percentage (100%)
Male	26	40
Female	39	60

In Table 2, based on respondent own assessment, about their experience/knowledge of respondent using computer have 3 responses, Beginner, Intermediate and Expert. Majority of the response answered Intermediate as their answer which 53 respondent (81.54%). Intermediate which mean the respondent has basic skills and knows a little bit of technical skill in troubleshooting/fixing/using the computer.

Table 2: Experience/Knowledge using computer

Response	Respondent (65)	Percentage (100%)
Beginner	8	12.31
Intermediate	53	81.54
Expert	4	6.15

Type of computer currently the respondent have or owns, 41 (63.08%) respondent responded that they own Laptop/Netbook only and 20 (30.77%) respondent have Laptop and Personal Computer/Desktop in Table 3.

Table 3: Type of computer currently own

Response	Respondent (65)	Percentage (100%)
Personal Computer/Desktop (Only)	4	6.15
Laptop/Netbook (Only)	41	63.08
Both	20	30.77

Table 4: Current operating system used/installed

Response	Respondent (65)	Percentage (100%)
Microsoft Window	58	89.23
Mac OS	1	1.54
Linux	0	0
Dual OS (Two or More OS installed in one computer)	6	9.23
Others	0	0

Table 5 showing the current operating systems installed in the respondent computer are genuine and preinstalled during purchase. Genuine software mean the software have license not pirated and preinstalled mean the computer comes with the operating system during purchase usually included with recovery partition or cd recovery reinstallation purposes. 34 (52.31%) respondents stated that their operating systems are genuine and 23 (35.38%) respondents stated their operating system not genuine. 29 (44.62%) respondent stated that their operating system came preinstalled during purchase and 28 (43.07%) respondent said the operating system preinstalled and no installation required.

Table 5: Current operating system genuine and preinstalled during purchase

Response (65 Respondent)	Yes	No	Not Sure
Genuine	34 (52.31%)	23 (35.38%)	8 (12.31%)
Preinstalled	28 (43.07%)	29 (44.62%)	8 (12.31%)

In Table 6, there were extra cost of for the respondent to installed the operating system which 29 (44.62%) of the respondent stated that. While 28 (43.07%) respondent stated there were no cost for the operating system during computer purchase.

Table 6: Extra cost for the operating system to be installed in the computer

Response	Respondent (65)	Percentage (100%)
Yes	29	44.62
No	28	43.07
Not Sure	8	12.31

Majority of the respondent stated that not willing to pay for the Microsoft Windows License for future upgrade and when purchasing new computer which 59 (90.77%) of the respondent. While only 5 (7.69%) respondent willing to purchase the operating system license. Among of comment of the respondent that reluctant to purchase the operating system were the cost of the license quite expensive and prefer that amount to be used in other matters. In Microsoft Online Store (http://www.microsoftstore.com/store/msapac) showing the price of Microsoft Windows Pro Upgrade (Student Price) cost RM215.00, Microsoft Store (2013).

Table 7: Willing to pay for the operating system (Microsoft Windows) license in future upgrade or purchasing new computer.

Response	Respondent (65)	Percentage (100%)
Yes	5	7.69
No	59	90.77
Not Sure	1	1.54

As listed in Table 8, there were 63 (96.92%) of the respondent not reluctant to use the pirated software in their computer as coherent with the result in Table 7 which the cost were main of their concern. As stated by Lau (2006) and Kirby (2000), pirated software easily to obtain by just purchase at the cd store or just by downloading the software from pirated website. Why the users prefer using pirated software because of free/low cost rather than purchasing the license software which quite expensive.

Table 8: Not reluctant to use pirated software in the computer

Response	Yes	No	Not Sure
Use Pirated Software	63 (96.92%)	1 (1.54%)	1 (1.54%)
Cost	63 (100%)	0 (0%)	0 (0%)

In Table 9, showing majority of the respondent has used/heard about Linux, and among of their comment was the operating system easily can be downloaded from the internet and free. Also more than half of the respondent, 43 (66.15%) stated that they will try/change to Linux as their operating system (see Table 10).

Table 9: Have used/heard about Linux Operating system

Response	Respondent (65)	Percentage (100%)
Yes	43	66.15
No	8	12.31
Not Sure	14	21.54

Table 10: Will try/changes the operating system to Linux as alternative to Microsoft Windows

Response	Respondent (65)	Percentage (100%)
Yes	43	66.15
No	3	4.62
Not Sure	19	29.23

Discussion

As indicated by BSA - The Software Alliance (2012, May 12), about 78% of computer users in Malaysia disclose that they have acquired pirated software in the 2011 BSA Global Software Piracy Study. Certain users say they pirate all or most of the period. Others say they do it infrequently or rarely. Software piracy is the illegal copying or distribution of copyrighted software. This can be done by copying, downloading, sharing, trade, or installing several copies onto personal or work computers. The issues have become like a plaque and installing pirated software become like a norms and for the user seem that is legitimate for them.

To overcome this plaque, the people should be educated the important regarding the intellectual property and this task should be embedded as early as possible. As a student, they has been expose to lots of software because the needs to use the software in teaching and learning process. The academician should counsel the student regarding using pirated software in their computer and provide list of alternative software for them. As cost become the main concern on purchasing the software license because of their attribute and when new license purchasing required for upgrading to latest version of the software. The respondent reluctant to purchase the license as they stated the amount of money for the license can be used for other purpose.

Because of the respondent already aware of the existence of open source software especially the operating system likes Linux. They should explore more on that and if there any issues or problems arise, they can ask for help and support from the open source community. Open source software fully backup by strong and devoted community because of their nature as the software development meant for the user itself also commercial company who sponsor the software. The community weren't being paid but the devoted to the open source because want the software to become better each release cycle by fixing the bugs and add more function to the software. Also requesting support from commercial company like Redhat and Caniocal, a small of fee required to the user and this is not for the license fee but for the support subscriptions.

In Table 11 showing the top 100 Linux operating distribution in Distrowatch (http://www.distrowatch.com/) , Bodnar (2013), respondent may choose any one of the distribution for their use.

Table 11: The list of top 100 Linux distributions in the world.

Mint	Chakra	Descent|OS	Semplice
Mageia	Kubuntu	ZevenOS	NetBSD
Ubuntu	Kali	Parted Magic	DragonFly
Debian	ROSA	Tiny Core	Trisquel
Fedora	antiX	Deepin	OpenBSD
openSUSE	Xubuntu	UberStudent	Salix
PCLinuxOS	Gentoo	DreamStudio	CRUX
Arch	Slax	Netrunner	LuninuX
Manjaro	Ultimate	Damn Small	Joli OS
Puppy	Red Hat	Clonezilla	aptosid
CentOS	Elive	Bridge	Wifislax
Zorin	elementary	MEPIS	Calculate
Bodhi	Peppermint	Korora	Solaris
Snowlinux	KNOPPIX	Slackel	Zentyal
OS4	Pinguy	PureOS	Unity
CrunchBang	Porteus	Frugalware	SUSE
Slackware	Scientific	Linpus	Oracle
SolusOS	PC-BSD	GhostBSD	Absolute
Lubuntu	Mandriva	Vector	SliTaz
FreeBSD	Tails	wattOS	FreeNAS
Sabayon	BackBox	siduction	Super OS
Pear	ClearOS	Ubuntu GNOME	Macpup
SparkyLinux	Ubuntu Studio	Parsix	2X
Lite	OpenELEC	Pardus	Zenwalk
Antergos	ArchBang	SystemRescue	AV Linux

Computer owner have no reason to use the pirated software because the availability of the alternative operating system and also application software. In this scenario, the students should explore because it can help them in their future in using the alternative software. If they feel using pirated software is not an issues they are wrong because this habit can become part of them when they started to works. They should stop and never practise in their daily life and in their office. Prevention is must more better than cure.

Conclusion

Open source operating system can be the alternative substituting the commercial/license operating system like Microsoft Windows. Linux operating system has becoming more users friendly and easy to use since it first introduce in 1991. More and more distribution of the Linux operating have emerge into the community and fully backup by the community and their sponsor. Now the main issues is to find the suitable Linux distribution that suit the user needs then they can just downloaded the ISO of that Linux distribution. Upgrading to newer version is much easier by just using the application inside the operating system and the cost for upgrading very cheap/free. Also Linux suitable to be installed in old computer because of the minimal requirement and even it can run by just using flash drive or cd.

Linux can be great beneficial to the society and this benefit needs to share with other and people who want this open source software continuity become better, their voluntary help is needed.

Acknowledgement

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Maintenance Performance of the Kwanyaku Water Treatment Plant

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Abstract

The study assessed the Maintenance Performance of the Kwanyaku Water Treatment Plant. Availability and reliability of eleven facilities from the old and Jubilee treatment plants were compared. Twenty respondents view on the Maintenance Schedule at the Kwanyaku Headworks was also obtained. The t-test was the main statistical tool used with an alpha level of 0.05. There were significant differences in the availability of the equipment at the two treatment plants where the old recorded 93.33% better than the jubilee 77.50%. Also, there were significant differences in the average reliability of 48.20 days and 11.00 days for the facilities at the old and the jubilee plants respectively which fell below the GWCL benchmark and plant manufactures' standard. The assessment further revealed significant differences in the maintainability of the two plants which were within the GWCL benchmark of 1 – 5 hours. Finally, the study revealed that the main causes of frequent plants and equipment failure at the treatment plant were power outages and instrumentation issues.

Key words: Water treatment, Kwanyaku

Introduction

Public water industries in the developing countries are often associated with poor operation and maintenance of infrastructural facilities. Thus more than half of the water produced is unaccounted for (Kendie, 2002 and Ittisa, 1991). According to Yepes (1990), the major contributing factors to the high unaccounted water are high levels of leakage and pipe burst. This is estimated as four (4) times higher than normal level in developing world. Also, lack of modern facilities to reduce the complexity of maintenance and computerized systems to facilitate and properly monitor the distribution net work contribute to the poor maintenance situation (World Bank, 1999).According to World Health Organization (2000), it is estimated that 30%-60% of existing water supply systems are not operational due to ineffective planned maintenance management system.

The growing attention to maintenance has not only occurred because investment in machinery, instrument and equipment in water treatment plant forms a significant part of the company's assets, but also because it is now realized that the cost of maintenance must be justified by the utilization of these equipment. Because of automation of the water treatment plant, the production equipment must be operated efficiently and without any unscheduled stoppages. It is therefore becoming more and more necessary to exercise a close control over the frequency of maintenance required by these plants. To ensure maximum plants availability, utilization and reliability, there must be an effective planned maintenance management system in place. Implementing preventive maintenance requires a great amount of time and effort to be invested on plants and equipment. This will ensure that the maintenance effort is concentrated on the areas where it will be most beneficial (Mather, 2002a; Harms and Kroon, 1992).

The aim of this study was to assess the Maintenance Performance of the Kwanyaku Water Treatment Plant. It is also to compare the performance of the two plants (old and jubilee plants) at the headworks against the GWCL benchmarks.

Materials and methods

Study Area

The Kwanyaku water treatment plant supplies portable water to eight districts in the central region. The Kwanyaku water supply system with present capacity of $35,000m^3/d(7,700,000gal/d)$ located about 10km east of Agona Swedru, was built in 1964 to supply water to Kwanyaku and other surrounding towns and villages (GWCL, 2007). It is a conventional treatment plant which takes the raw water from the Ayesu River, is impounded, treated and transmitted through a distance of about 300km to serve a population of over 750,000 inhabitants.

Research Design

Comparative research method was used in this study without manipulating any variable.

Population and Sample

All seventy-eight (78) plants and equipment at the Kwanyaku Headworks formed the population of the study. Purposive non-random sample was used to select eleven (11) facilities each from the old plant and the jubilee plant. Also, purposive non-random sample was used to select twenty (20) respondents, made up of maintenance and production departments for the study.

Instrumentation

Two main instruments were used for the study. A questionnaire was used to collect information on maintenance management activities at the treatment plant. Another instrument, the performance checklist was used to collect data on the performance of all the plants and equipment at the headworks for the most recent six (6) months.

Data Analysis

Independent samples t-test technique was used in analyzing the data.

Results

This section attempts to ascertain if there was any significant difference between the old plant and jubilee plant with regards to plant availability. From table 1, the independent samples t-test was used to determine whether the difference in availability of the two plants was significant. The results indicated that all the equipment on the old plant recorded higher availability than those on the jubilee plant and the differences in the availability levels were significant at 1% level of probability. The minimum and maximum plant availability values for the equipment installed on the old plant were 85.67% and 94.0%, respectively. In the case of the equipment installed on the jubilee plant, the minimum and maximum availability values were found to be 69.83% and 78.0%, respectively. The test indicated that the difference for the two plants in the case of low lift pumps were statistically significant ($t = 5.034$, $p < 0.05$). Similar results were indicated by the aerators ($t = 4.956$, $p < 0.05$). The result was significantly the same in the case of the overhead cranes (t

= 5.146, p < 0.05). The results showed the same trend for the clari-flocculators (t = 4.876, p < 0.05).The high lift pumps were significant at (t = 4.951, p < 0.05). Similar difference of (t = 4.951, p < 0.05) was recorded for air blower pumps while the control panels recorded a significance of (t =4.991, p < 0.05.

Table 1. Plant Availability for old and Jubilee plants

Plant Description	Old Plant		Jubilee Plant		t-test	p-value
	M	SD	M	SD		
Low lift pumps	93.33	0.0345	77.50	0.0689	5.034	0.01*
Aerators	93.33	0.0345	77.33	0.0712	4.956	0.01*
Clari-flocculators	93.50	0.0288	77.50	0.0750	4.876	0.01*
High lift pumps	93.33	0.0345	75.50	0.0704	4.951	0.01*
Air blower pumps	93.50	0.0362	77.67	0.0695	4.951	0.01*
Control panels	94.00	0.0323	77.67	0.0734	4.991	0.01*
Overhead cranes	94.00	0.0323	78.00	0.0690	5.146	0.00*
Rapid gravity filters	85.67	0.0327	69.83	0.0725	4.877	0.01*
Wash water pumps	94.00	0.0323	78.17	0.0720	4.919	0.01*
Chemical dosing pumps	85.67	0.0327	69.83	0.0725	4.877	0.01*
Transformers	93.83	0.0306	78.00	0.0729	4.903	0.01*

* Significant level 0.05   M = Mean; SD = Standard deviation

The results indicated the same significant difference of (t = 4.877, p < 0.05) for the rapid gravity filters and the chemical dosing pumps. The wash water pumps and the transformers recorded a significant difference of (t = 4.919, p < 0.05 and t = 4.903, p < 0.05) respectively.

This section considers differences between reliability of the old plant and the jubilee plant. The results of the analysis as shown in table 2 indicated that there was a significant difference between the old plant and the jubilee plant in terms of plant reliability. The results showed that all the equipment on the old plant recorded higher reliability than those on the jubilee plant and the differences in the reliability levels were significant at one level of probability. The minimum and maximum plant reliability values for the equipment installed on the old plant were 14.15 days and 57.93 days, respectively. In the case of the equipment installed on the jubilee plant, the minimum and maximum reliability values were found to be 6.45 days and 12.32 days, respectively. The results showed that the aerators and the clari-flocculator were highly significant at (t = 3.552, p <0.05 and t =3.199, p < 0.05) respectively. Similar results were noted in the high lift pumps and the air blower pumps at (t = 3.516, p < 0.05 and t = 3.652, p < 0.05) respectively. The analysis registered another statistically significant difference, t =2.998, p < 0.05 on the control panels.

Table 2. Plant Reliability for old and jubilee plants

Plant Description	Old Plant		Jubilee Plant		t-test	p-value
	M	SD	M	SD		
Low lift pumps	40.900	17.160	11.000	4.521	4.127	0.070
Aerators	39.400	18.420	11.683	5.094	3.552	0.013*
Clari-flocculators	57.933	35.941	11.700	5.151	3.119	0.025*
High lift pumps	39.400	18.420	12.317	4.077	3.516	0.015*
Air blower pumps	39.467	18.479	11.083	4.567	3.652	0.012*
Control panels	55.900	35.968	11.467	4.925	2.998	0.029*
Overhead cranes	56.467	35.811	11.985	5.349	3.009	0.028*
Rapid gravity filters	14.150	2.8381	6.450	1.946	5.481	0.000*
Wash water pumps	56.500	35.784	11.983	5.348	3.014	0.028*
Chemical dosing pumps	14.150	2.8381	6.450	1.946	5.481	0.000*
Transformers	56.871	35.319	11.983	5.371	3.078	0.026*

* Significant level 0.05   M = Mean; SD = Standard deviation

The results indicated statistical significant difference for the overhead cranes at t = 3.009, p < 0.05 whilst similar difference was noted in the wash water pumps, t =3.014 p < 0.05. Again, both the rapid gravity filters and the chemical dosing pumps showed a statistically significant difference at t = 5.481, p < 0.05. The transformers also recorded significant difference (t =3.078, p < 0.05).

This section seeks to determine whether there was any significant difference between maintainability of old plant and jubilee plant. The results revealed that all the equipment on the old plant recorded higher maintainability than those on the jubilee plant and the differences in the maintainability levels were significant at one level of probability. The minimum and maximum plant maintainability values for the equipment installed on the old plant were 2.18 hours and 2.87hours, respectively. In the case of the equipment installed on the jubilee plant, the minimum and maximum maintainability values were found to be 2.65hours and 3.42hours, respectively. The results in table 3 revealed that there was a statistically significant difference between the old plant and the jubilee plant in terms of plant maintainability. A statistically significant difference was noted in terms of aerators, t = -3.579, p < 0.005. The results indicated that the rapid gravity filters and the chemical dosing pumps were statistically significant at (t = -2.427, p < 0.05).

Table 3. Plant Maintainability for old and Jubilee plants

Plant Description	Old Plant		Jubilee Plant			
	M	SD	M	SD	t-test	p-value
Low lift pumps	2.3500	0.5320	2.883	0.4021	-1.959	0.081
Aerators	2.1833	0.4708	3.083	0.3971	-3.519	0.005*
Clari-flocculators	3.1833	0.9928	3.050	0.5505	0.288	0.781
High lift pumps	2.3333	0.5391	3.417	1.2400	-1.963	0.078
Air blower pumps	2.3333	0.5391	2.900	0.3464	-2.166	0.060
Control panels	2.7667	0.4676	2.983	0.3971	0.865	0.408
Overhead cranes	2.7167	0.4834	3.000	0.3899	-1.118	0.291
Rapid gravity filters	2.2667	0.2582	2.650	0.2881	-2.427	0.036*
Wash water pumps	2.7333	0.4803	2.983	0.4021	-0.978	0.352
Chemical dosing pumps	2.2667	0.2582	2.650	0.2881	-2.427	0.036*
Transformers	2.8667	0.5317	3.017	0.4262	-0.539	0.602

* Significant level 0.05   M = Mean; SD = Standard deviation

Table 4 shows the frequency at which plants and equipment were maintained at the treatment plant. From table 4, respondents were asked to indicate the frequency at which maintenance was carried out at the treatment plant. Most of the respondents (80%; n = 16 and 85%; n = 17) indicated that the clear wells and the transformers respectively were maintained annually per the planned maintenance schedule. Three-fifth (60%; n = 12) of the respondents indicated that both the electric and induction motors were monthly inspected and defects corrected. Almost (90% n = 18) all the respondents showed that the chemical dosing systems, aerators and clari-flocculators were monthly inspected and maintenance carried out. In terms of the rapid gravity pumps, half (50%; n = 10) stated that planned maintenance is carried quarterly. Majority (85%; n = 17) of the respondents reported that the low lift pumps, high lift pumps and sludge pumps were inspected and maintenance carried out monthly per the planned maintenance schedule at the headworks. More than two-thirds of the respondents (75% n = 15) showed that the cranes and the hoist were inspected and maintained annually. With the control panels, three-fifth (60%; n = 12) of the respondents indicated that the maintenance crew quarterly inspects and reconditioning the system.

Table 4. Respondents View on the Maintenance Schedule at the Kwanyaku Headworks

Plants and Equipment	Frequency			
	Monthly	Quarterly	Half-yearly	Yearly
Clear wells/reservoirs		10%	10%	80%
Transformers		5%	10%	85%
Motors	60%	30%	10%	
Rapid gravity filters	25%	50%	25%	
Chemical dosing systems	90%	10%		
Air blowers or compressors			15%	85%
Low lift pumps	85%	15%		
High lift pumps	85%	15%		
Sludge pump	85%	15%		
Aerators	90%	10%		
Clari-flocculators	90%	10%		
Cranes/Hoists			25%	75%
Control panels		60%	40%	

Table 5. Staff Responses on Possible Causes of Maintenance Outages

Maintenance Outages	Frequency		
	Major Causes	Minor Causes	Total
Mechanical Outage	25%	75%	100%
Power Outage	90%	10%	100%
Instrumentation Outage	60%	40%	100%

As showed in table 5, respondents were asked to indicate the causes of frequent maintenance outages with respect to the Kwanyaku Headworks. Three-forth (75%; n = 15) of the respondents perceived mechanical outage as a minor cause of frequent breakdowns of plants and equipment at the headworks. Majority (90%; n = 18) of the respondents indicated that electrical outage was the main cause of frequent breakdown of the treatment plant. More than half (60%; n = 12) of the respondents showed that instrumentation outage also contributes to the frequent downtimes of the treatment plant.

Discussions

With regards to plant availability, the study found a significant relationship between the old plant and the jubilee plant at the headworks. The finding confirms the assertions made by Robinson (1993), Simpson (2006), Atepor (2005a) and Clifton (1987) that plants must be made available to operate in an efficient manner at the required level of production and there must be no unscheduled stoppages. This difference in plant availability could be attributed to certain situational factors. For instance, data indicated that the jubilee plant experienced frequent power outages which forced the plant out of production for several hours as compared to the old plant. The reason could be the frequent interruption of power supply to the jubilee plant which can only operates on 33kVA power supply. This finding corresponds to the research conducted by (Davis, 2003; Mather, 2002c; Dunn, 1997) who submitted that every plant or equipment is unique and

acts and behaves differently in different environments and that a piece of equipment cannot be compared with another equipment but can only be benchmarked against its own performance. For example at the old plant, the low lift pumps and the high lift pumps were available at 93.33% for production while 6.67% downtime was recorded for preventive maintenance and breakdown maintenance. This means that very little maintenance was undertaken and the danger is that major plant failure could occur due to lack of maintenance. For the jubilee plant at the same period, the low lift pumps and the high lift pumps were operated at 77.50% plant availability while 22.50% downtime was recorded for maintenance outages. This also implies that planned maintenance was not practiced. This finding was inconsistent according to GWCL benchmark of 90%, which is 7% for preventive maintenance and 3% for breakdown maintenance.

The study reveals that there was a significant difference between the old plant and the jubilee plant in terms of plant reliability. This finding collaborates with the study conducted by Mather (2002b) and Camp (1989) that plant must operate continuously without failing during a specified time schedule. This difference in plant reliability could be the same as indicated in plant availability. For example in the old plant, the high lift pumps and the wash water pumps were reliable at 39.40 days and 56.50 days, respectively. This implies that the high lift pumps and the wash water pumps could only trip or fail every 39.40 days and 56.50 days, respectively. The situation at the jubilee plant was different as plant reliability of 12.32 days and 11.98 days were recorded for the high lift pumps and the wash water pumps respectively. This shows that the high lift pumps and the wash water pumps were continuously operated for 12.32 days and 11.98 days respectively without failure. Both findings were at variance with GWCL target of 264 - 336 hours (11 - 14 days) of low mean time between failures (MTBF).

The study further revealed that there was no significant correlation between maintainability of the old plant and the jubilee plant. It is not surprising therefore that no difference in the maintenance of the two treatment plants at the headworks was observed, since the lifespan of equipment depends to a large extent on the maintenance services offered, simply because maintenance poses a lot of challenges to management. However, results recorded at the two plants (old plant and jubilee plant) were in agreement with GWCL benchmark of 1 - 5 hours of low mean time to repairs (MTTR). This implies that maintenance services at the headworks were carried out between 2 – 3 hours. For instance, maintenance services on the high lift pumps were completed within 2.33 hours and 3.42 hours for the old plant and the jubilee plant respectively. According to Simpson (2006) and Atepor (2005b) plants must operate efficiently and accurately at the required level of production and there must be no unscheduled stoppages. This empirical revelation is in conformity with O'Conner's (1999), Campbell's (1995), Dilworth's (1993), Dunlop's (1990) and Clifton's (1987) findings that maintenance activities are designed to keep plants and equipment in good operating condition or to restore it to accept standard after it has failed. This refers to the activities aimed at keeping existing capital assets in serviceable conditions. That is, the activities required to sustain plant in proper working conditions. The report argued that the purpose of maintenance is to provide safe, enhanced and efficacious maintenance service to obtain optimum plant availability factors, which will be cost effective and harmonious.

Results indicated that the main causes of plant failure at the headworks especially at the jubilee plant were the frequent power and instrumentation outages. This finding statistically confirms the hypotheses. Moreover, findings from respondents indicated that maintenance was most often carried out per the planned maintenance schedules of the company. This affirms an assertion made by Clifton (1987) and Lindley and Hinggins (1988) that planned maintenance prevent unscheduled stoppages and thereby increase the lifespan

of plant and equipment. The assertion added that the benefits of planned maintenance include greater plant availability and reliability, effective tools, materials and labour utilization, improved budgetary control, improved stock control of spares and provision of information upon which management can make realistic forecasts and decisions.

Conclusions

The study has established that statistically significant differences exist between the two plants. The areas of differences are: majority of facilities at the old plant operated above the required duration in the months as against the jubilee plant facilities which operated slightly below the designed capacity. Again, the average low mean time between failures (MTBF) of facilities at both plants fell below GWCL benchmarks and plant manufactures' standards. However, the low mean time to repairs (MTTR) of the two plants was carried out within the GWCL benchmarks and plant manufactures' standards as the treatment plant has only one maintenance personnel.

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The Black Olive Fruits of Jijelian Sigoise Variety (Eastern Algeria): Quality Evaluation for Possible Use as Table Olives and Pesticides Research

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Abstract
Black olive fruits of Jijelian *Sigoise variety* (Eastern Algeria) were investigated mainly for physico-chemical composition, microbiological parameters and pesticide research. Carpological results reveal that black olive fruits of Jijelian *Sigoise variety* are suitable for processing as table olives (weight fruits: 3.40 ± 0.28 to 5.95 ± 0.42g). The moisture contents of olive fruit varied between 9.95% and 17.94%. Ash was in the range of 4.60 ± 0.08 % in the samples S03; 7.10 ± 0.03% in the sample S04 and 7.99 ± 0.14% in the sample S02. The olive fruits of sample S01 were characterized by the lowest organic matter (74.25 ± 0.57%) and the highest ash matter (12.00 ± 1.08%). Titrable acidity value for all samples ranges between 7.21 ± 0.30 and 12.46 ± 0.22 (mg/g of flesh). The total amount of phenols among olive fruits was different. The total phenol content as gallic acid equivalent in all samples ranged from 578.40 ± 1.76 to 1059.04 ± 2.35 (µg/ml of flesh). Pesticide research has revealed the presence of an adjuvant to some pesticides (abamectin, delthamethrine) which is butylated hydroxytoluene (BHT) with a concentration of 0.43%.The black olive fruits used in this study were considered valuable for table olives production and one out of three samples contained pesticides

Keywords: Black olives, Sigoise variety, Table olives, Physico-chemical properties, Pesticides

Introduction

The production of table olives in the world is mainly concentrated in the Mediterranean region. In European Union, Spain, Italy, Greece, Portugal and France are the best producer countries. Table olives are a traditional Mediterranean product and, like olive oil and red wine, are one of the most important components of the Mediterranean diet. The Trade Standard Applying to table olives (COI/OT/NC N°1 2004) defines table olives as "the product prepared from the sound fruits of varieties of the cultivated olive tree (*Oleae europaea* L.) that is chosen for their production of olives whose volume, shape, flesh-to-stone ratio, fine flesh, taste, firmness and ease of detachment from the stone make them particularly suitable for processing". Different kinds should be classified according to the fruit ripeness stage, trade preparation, styles and sizing.

In East Algeria (Jijel) olive tree is one of the major agricultural trees with an area of 14,500 hectares distributed essentially in mountainous areas**.** The majority of the olives grown are dedicated to the production of olive oil. In this area, *Sigoise variety* of *Olea europea* was implanted at the end 1990, to develop the production of table olives, whose production is exclusive to Western Algeria (Anonymous, 2009). Sigoise variety is characterized by ratio flesh / stone (average 6.44); high sugar content (greater than 4%) (Balastouras, 1976), salt water tolerant, resistant to cold and drought; precocious flowering; easy harvesting, performed almost entirely by hand; good pollinator of *Chemlal variety* (Mendil and Sebai, 2006)**.**
In East Algeria, olive fruits are harvested when fully matured and completely dark by hand or by knocking the fruits from the tree with a slender pole or by shaking the branches and collecting the fruits from the ground. Contamination of the fruits by hazardous microorganisms may occur while falling unavoidably on the ground or by workers while harvesting handling and working the fruits. The natural fermentation is particularly influenced by the characteristics of the natural olive cultivar, so investigation on olive productions is necessary. In the present study black olive fruits of *Sigoise variety* were evaluated for their physico-chemical composition, microbiological characteristics and pesticide research with the main objective of evaluating the availability of the olives for table olives processing.

Materials and Methods

Samples collection

Four samples of black olives, Sigoise variety were collected from four regions such as Texanna (S01); Kaous (S02); Sidi Abdelaziz (S03) and Settara (S04) in Jijel, East of Algeria. Fruits were harvested between the end of September and the second week of November, at a maturity stage suitable for processing. For each sampling, five Kg of black olives was collected and immediately transported to the laboratory.

Microbiological analysis

In order to evaluate the microbiological quality of black olives fruits (*Sigoise* variety)*,* 10g of each sample was diluted in 90 ml of Ringer solution, homogenized and the appropriate dilutions were plated in triplicate onto appropriate media. The analyses were done in triplicate and the plates were subjected to microbiological numbering by CFU counting.

The media and the conditions used for microbial numeration were the following : Plate Count Agar (PCA), incubated at 37 °C for 48 h for mesophilic bacteria ; Man Rosa-Sharpe Agar (MRS) incubated at 32°C for 48h to 72h in anaerobiosis for lactic acid bacteria; Violet Red Bile Glucose Agar (VRBG) incubated at 37°C for 24-48h for Enterobacteria; King A Medium, incubated at 30°C for 48 h for *Pseudomonas* ; Violet Red Bile Lactose Agar (VRBL) incubated at 37 °C for 24-48 h for total coliforms, and 44 °C for 48 h for fecal coliforms; Oxytetracycline Glucose Agar (OGA) pH 3.5 incubated at 25°C for 5 days for yeast and moulds, Baird –Parker Agar base, incubated at 37°C for 24-48 h for staphylococci and micrococacea (Campaniello et al., 2005; Kacem and Karam, 2006 and Idoui et al., 2009).

Physico-chemical determination

Carpological parameters: length (mm), diameter (mm), fruit weight (g), stone weight (g), flesh weight (g) and ratio flesh /pit were carried out on 50 fruits randomly sampled from the entire amount (Poiana and Romeo, 2006).The analyses were done in triplicate.pH measurements were determined by the use of pH-meter (HANA pH-521). Free acidity was determined according to AOAC (1990). Ten ml of extract olives was dissolved in a mixture of 10 ml of isobutanol- ethanol solvent and 10 ml of alcoholic potassium hydroxide. Titration was achieved by HCl solution (0.5 N) and using a few drops of phenolphthalein as indicator solution. The analyses were done in triplicate.

Determination of moisture content was made according to the following procedure: an initial mass of olives was drying at 105°C ± 1 °C. Sample weight was determined after each time interval (5 min) until stabilization. Method described by Fernandez-Diez and Adams (1997) was used for the determination of dry matter content. It was assessed by oven drying at 105°± 1°C. Olive samples were transferred to a muffle furnace at a temperature of 900°C to complete the combustion of carbon. Once the residue of combustion was colored white, the residue of combustion was weighted. Organic matter content was calculated by the difference between dry matter and ash. The analyses were done in triplicate.

Total polyphenols were extracted after vortexing 5 g of olive flesh with 10 ml of hexane and 10 ml of methanol-water mixture (6v / 4v). Total volume was separated by centrifugation. The lower phase was collected. Methanol-water mixture was added to the upper phase, and the process of centrifugation was repeted. Solvent was added to the lower volume obtained. 0.5 ml of Folin-Ciocalteu's reagent was added to 0.2 ml of the total polyphenols extract. After 3 min, 4 ml of sodium carbonate (1M) was added to the solution and supplemented with distilled water. Preparation were kept in the dark for 90 min. Concentration of total polyphenols was measured spectrophotometrically at 725 nm, and expressed as mg/kg of gallic acid by means of a calibration plot using pure gallic acid as standard (Nassif, 2004). The estimation of total phenolics compounds in the extract was carried out in triplicate.

Pesticides research

A sample preparation procedure for the analysis of pesticides in fresh olives was described by Jon (2008). Olive sample of 25 g were extracted in 60 ml of acetonitrile for 1 min, 50 g anhydrous sodium sulfate was added, and the extraction continued for another 2 min using an homogenizer at 9500 rpm. After centrifugation at 4000 rpm for 3 min, the extraction vessel was transferred to a freezer for a minimum of 4 h or over night. Upon removal from the freezer, part of the organic phase was transferred to a small beaker leaving the solids behind (including

the frozen oil). A 12 ml (9.43 g) portion of the extract, measured by mass, was transferred to a 100 ml round-bottom flask and evaporated to dryness. The residue was reconstituted in 2 ml acetonitrile. Purification step was performed on activated silica gel (45 °C for 4 h). The elution of the sample was made by 10 ml of acetonitrile. The eluate was concentrated at second time in a rotary evaporator (40 °C), then again with 2 ml of acetonitrile. 1μl of the final extract was injected into the GC-MS.

Statistical analysis

Statistical comparison of data was performed by ANOVA to reveal significant differences for each parameter among samples. A probability value of $P < 0.05$ was adopted as the criteria for significant differences.

Results and Discussion

Microbiological Analysis

The microbial count of Sigoise olive fruits was reported in Table 1. The count of mesophilic bacteria is between 18 and 32×10^7cfu/g. The enterobacteria counts ranged from a count of 3 and 7×10^5cfu /g. *Staphylococci*, *Micrococcaceae* and fecal coliforms were not detected in all samples. Also, counts of lactic acid bacteria and total coliforms were between 13 and 20×10^7cfu/ g and 9 and 33×10^3cfu / g respectively. The presence of total coliform bacteria is probably due to olives fecal contamination by contact with the ground during harvesting and storage in unhealthy places.

Table1. Counts of microbial population in sigoise olive samples

Flora	Sample			
	S 01	S 02	S 03	S 04
Mesophilic bacteria (10^7cfu/ g)	18 ±0,01[a]	20±0,05[a]	26±0,10[a]	32±0,04[a]
Total coliforms (10^3cfu/ g)	9±0,02[b]	12±0,04[b]	12±0,01[b]	33±0,06[b]
Thermotolerant coliforms (10^2cfu/g)	00	00	00	00
Enterobacteria (10^5cfu/ g)	4±0,0[a]	6±0,09[a]	3±0.4[b]	7±0,03[b]
Yeast (10^6cfu/ g)	41±0,06[a]	47±0,08[c]	70±0,05[c]	67±0,14[d]
Mould (10^5cfu/ g)	26±0,22[a]	24±0,12[b]	10±0,06[c]	34±0,0[d]
Lactic acid bacteria (10^7cfu/ g)	13±0,01[a]	20±0,09[c]	13±0,18[a]	14±0,02[a]
Staphylococci (10 cfu/g)	absence	absence	absence	absence
Micrococaceae (10cfu/g)	absence	absence	absence	absence

Results are expressed as means ± standard deviation of three measurements.   Means followed by a different letter are significantly different.

It should be emphasized that yeasts and moulds were present in high numbers relatively to the other groups of microorganisms, ranging between 41×10^6 and 70×10^6 cfu / g and 10 and 34×10^5 cfu / g respectvely. According to Guiraud and Rosec (2004) the pH of yeast overgrowth is pH 3 - 7.5, which explains their presence in all samples. According to Garcia and Yousfi (2005) damaged olives fruit in cases are a nest of infection from microorganisms. This gradual deterioration is accelerated by the presence of mechanically damaged fruits, which are particularly susceptible to infection by fungi. Stoning olives promote access of *Penicillium* and mould to nutrients. Lipid residue suggests contamination by *Penicillium* with high lipolytic activity. Such activity has been studied in some species of *Penicillium* and *Aspergillus* isolated from olives (Fares et al., 1985).

Carpological parameters

The carpological parameters of Sigoise black olives were reported in Table 2. Other carpological parameters, such as the length, stone, flesh and flesh to pit ratio, were quite significant for all samples. Carpological data reveal that cultivars are suitable for processing as table olives. Only sample S04 was classified, according to the IOOC (2000) as medium weight fruits (from 2 to 4g). Samples S01, S02, S03 have a high weight fruits (from 4 to 6 g). Balastouras (1976) showed that the average weight of olives "varieties Sigoise" varies from 4.5 to 5.5g.Values of the length and diameter of olives "Sigoise" present an apparent variability.

Table 2. Carporogical characteristics of sigoise olive samples

Sample	Length (mm)	Diameter (mm)	Fruit (g)	Stone (g)	Flesh (g)	Flesh / pit
S01	18.42±1.33[a]	14.50±0.68[a]	5.80±0.57[b]	0.41±0.23[a]	5.39±0.31[a]	13.15±0.76[a]
S02	20.52±1.22[b]	14.82±0.65[a]	5.95±0.42[b]	0.63±0.13[b]	5.32±0.46[b]	8.44±1.08[b]
S03	26.09±1.26[c]	18.41±1.23[a]	5.61±0.65[b]	0.56±0.14[c]	5.05±0.55[c]	9.01±0.63[c]
S04	18.41±1.18[d]	14.50±0.51[a]	3.40±0.28[b]	0.31±0.16[d]	3.39±0.20[d]	10.62±0.40[d]

Results are expressed as means ± standard deviation of three measurements.
Means followed by a different letter are significantly different.

Poiana and Romero   (2006) described some Italian olive varieties "Nocellara enta, Nocellara missinese, Moresca and Tonda Oliaglora iblea" destined to the production of table olive, the length and diameter ranged from (21.51-27.89) mm and (16.53-22.35) mm, respectively. Compared to our results, sample S03, which was characterized by a length of 26.09 mm and diameter 18.41mm is between the values found for "Oglialora" (21.51mm length, 16.53 mm diameter) and those of 'Tonda iblea "(26.89mm length, 20.37mm diameter). Based on the classification proposed by Brighigna (1998) all samples of Sigoise variety studied had a flesh/pit higher than 5 and so considered very good for table olives. It has been established that fruit quality varies from the seasons and this depend largely on several factors, and, according to Ouaouicha and Chimi (2007) the high temperatures of the spring causes the early loss of fruits and slowing the process of growth due to the excessive effect of evapotranspiration.

Physicochemical characteristics

Dry, ash, organic matter content and moisture of Sigoise olive fruits were reported in Table 3. The results showed that moisture varied between 9.95% and 17.94%; these variations were probable due to the difference in growing conditions, method of harvesting and irrigation (Tanilgan et al., 2007).As shown in the same table, Ash was in the range of 4.60 ± 0.08 % in the samples S03; 7.10 ± 0.03% in the sample S04; 7.99 ± 0.14% in the sample S02 and 12 ± 1.08 % in the sample S01. From the above data, significant differences between samples were observed. Our results are not in agreement with those reported by Ryan and Robards (1998) the sample S01 is characterized by the lowest organic matter (74.25± 0.57%) and the highest ash matter (12.00 ± 1.08%). However, Lopez et al. (2008) reported that variations of this parameter are due to the distribution of minerals in the soil, the stage of maturation, fertilization methods and chemical composition of fertilizers. In addition, dry mater content was not explained by the ripening stage of the fruit olives.

Table3. Dry, ash, organic matter content and moisture of sigoise olive samples

Samples	Ash (%)	Dry matter (%)	Organic matter (%)	Moisture (%)
S01	12.00±1.08[a]	86.25±0.51[a]	74.25± 0.57[a]	15.75±0.91[a]
S02	7.99± 0.14[b]	84.25±0.09[b]	76.26± 0.05[b]	13.04±0.76[b]
S03	4.60 ±0.08[c]	90.05±0.07[c]	85.45± 0.01[c]	9.95±0.77[c]
S04	7.10±0.03[d]	82.02 ±0.05[d]	74.92± 0.02[d]	17.94±0.78[d]

Results are expressed as means ± standard deviation of three measurements.
Means followed by a different letter are significantly different.

Titrable acidity value for all samples ranges between 7.21 ± 0.30 and 12.46 ± 0.22 (mg/g of flesh). According to Boskou (2009) the factors that lead to high acidity in the olives are: the invasion of the fruit by coachman, delays between harvesting and extraction, especially if the fruit was damaged or was bruised during harvest and fungal diseases in the fruit (*Gloesporium*, *Macrophoma*, etc). pH values of samples ranged from pH5.24 ± 0.27 and pH 5.96 ± 0.75. Similar results are found by Ghattas (2004).

**Table4.** pH, titrable acidity and total polyphenols of sigoise olive samples

Samples	pH	Titrable acidity (mg/g of flesh)	Total polyphenol (µg/ml of flesh)
S01	5.73± 0.50[a]	8.80± 0.55[c]	710.68±1.55[a]
S02	5.24± 0.27[a]	12.46 ± 0.22[c]	578.40±1.76[b]
S03	5.26± 0.11[a]	9.75± 0.07[c]	581.27± 3.99[c]
S04	5.96± 0.75[a]	7.21± 0.30[c]	1059.04±2.35[d]

Results are expressed as means ± standard deviation of three measurements.
Means followed by a different letter are significantly different.

As shown in Table 4, important differences were found in polyphenols content among black olives samples. Total polyphenols content of olives samples presented was variable, ranging from 578.40 ± 1.76 to 1059.04 ± 2.35 (µg/ml of flesh). From the above data, significant differences between samples were observed. These variations are probably due to maturity degree. According to Stupans et al. (2002) the polyphenol content decreases if the optimum stage of maturity is exceeded. Boskou et al. (2006); Tasioula and Okogero (2001); Visioli et al. (2000); Tanilgan et al. (2007) reported that infestation and geographical climate can influence the levels of these compounds. In addition, the water status of the tree affects the synthesis of phenolic compounds in olives.

Pesticides research

We detected and identified a peak corresponding to butylated hydroxytoluene (BHT) (peak 55, rt = 10 603 min) with a concentration of 0.43% (Figure 1); the NIST library integrated in our unit has confirmed the mass Spectrum identity of this molecule which seem to be an adjuvant to some pesticides (abamectin, delthamethrin) **(**EC-ISO 11014-1 2006). Cultures has not undergone any pesticide treatment, we believe that detection of butylated hydroxytoluene allows us to suspect the presence of pesticides which were degraded and eventually transferred by wind and / or groundwater from nearby greenhouses.
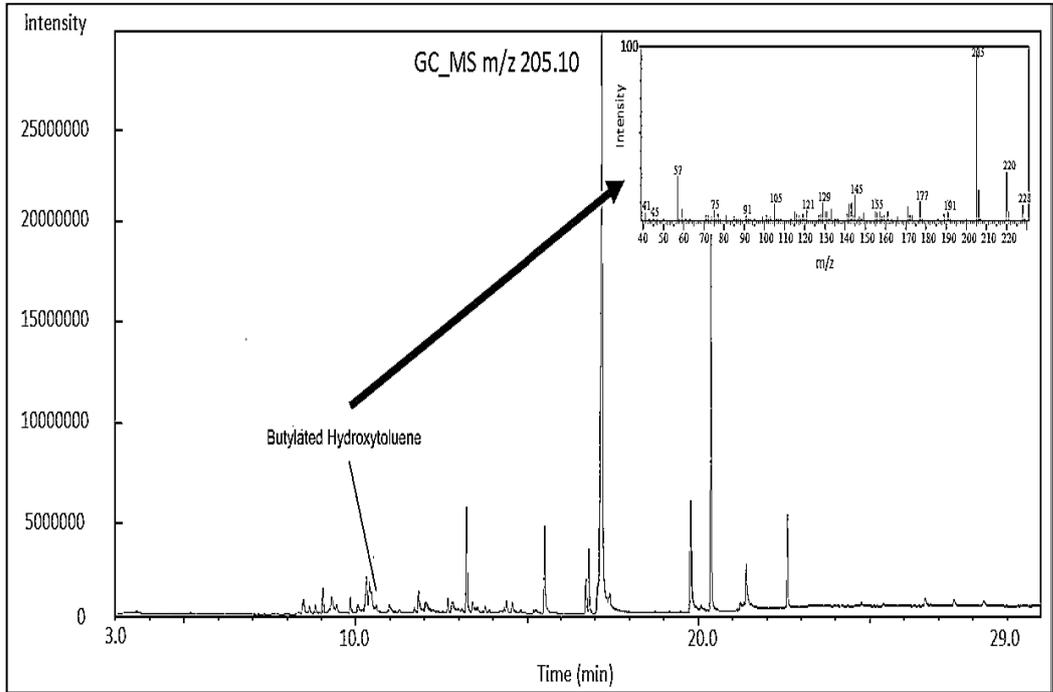
Figure1: Pesticides research in olive (case of sample"$S0_3$)

Also, the analysis of our olive sample shows peaks of varying concentration that revealed the presence of various constituents such as the matrix components which are mainly represented by fatty acids; oleic acid as a major peak (peak 104, rt = 17 195 min) with high concentration 26.58%, linoleic acid (peak 105, rt = 17,344 min) with a concentration of 0.13%, palmitoleic acid (pic89, rt = 14,941 min) with a concentration of 0.10% .Palmitic, stearic and eicosanoic acid (peaks 16, 22, 95) with the same concentration 0.02%. Carbohydrates (sugars): The 1Hydroxy, 3Hydroxy pyrano [3,4-c] pyran-5-carboxaldehyde (peak 87, rt = 14.56 min).Amino acids: The carbobenzenoxy-dl-histidine (peak 51, rt = 10.06 min). Alcohols: Benzyl alcohol (peak 7, rt = 4149 min).Esters: The 4 - pentanoic acid, methyl 3-methyl ester (peak 4, rt = 3511 min).Acids: The nonanoic acid (peak 33, rt = 7572 min). And contaminants whose 1, 2-Benzene decarboxylic (peak 125, rt = 20 336 min) with a concentration of 17.28%.

Conclusion

To our knowledge, no information existed on the quality of black olives fruits (Sigoise variety) cultivated especially in the East of Algeria. Our results showed that the characteristics of the olive fruits revealed their good quality for production of table olives and solely the sample coded SO_3 contained pesticides.

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The Effects of Economic Growth on Environment: An Application of Environmental Kuznets Curve in United Arab Emirates

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Abstract: The correlation between economic growth and environmental degradation is becoming important as a result of the concerns for environment and sustainable development. The correlation has been empirically modeled through CO_2 emissions and per capita income relationship by many researchers. The results of such researches have been formulated by environmental Kuznets curve (EKC) hypothesis. According to EKC hypothesis there is an inverted U-shape relationship between environmental degradation and income per capita so that, eventually, growth reduces the environmental impact of economic activity. Having such trend in a country is thought to be one of the most important indicators of sustainable economic development. The main objective of this study is to analyze the effect of economic growth on environment by applying EKC approach to UAE economy. The long-run EKC relationship for CO_2 emission and UAE's per capita income over the 1970- 2010 period was analyzed. An autoregressive distributed lag (ARDL) model was used to determine the effects of per capita income, openness ratio of UAE economy, and human development index (HDI) on CO_2 emission. According to the results there was a inverted-U shape relationship between CO_2 emission and per capita income of UAE. In addition to that even though there were expected significant negative effects of energy consumption, opening ratio and HDI on CO_2 emission, their effects were not statistically significant. According to results of the analysis one can conclude that the economic growth in UAE is leading a decent environment, which is supporting the EKC hypothesis.

Keywords: Environmental Kuznet Curve, Environmental Degradation, CO_2 Emission, Economic Growth

Introduction

The correlation between economic growth and environmental degradation has been an important topic as a result of the concerns for environment and sustainable development. The correlation has been empirically modeled through CO_2 emissions per capita, as an indicator of environmental pollution, and per capita gross domestic products (GDP), as an indicator of income growth. The results of such researches have been formulated by environmental Kuznets curve (EKC) hypothesis. According to EKC hypothesis there is an inverted U-shape relationship between environmental degradation and income per capita so that, eventually, growth reduces the environmental impact of economic activity (Grossman & Krueger, 1991). Having such trend in a country is thought to be one of the most important indicators of sustainable economic development.

According to Kuznets (1955) income inequality and per capita income increases together at the first stage of development. After some turning points of development the inequality starts to decline. So the inequality of income is more in early stages of economic development but later the distribution of income move toward equality. There is a bell shaped curve relationship between per capita income and income inequality known as Kuznets Curve. Grossman and Krueger (1991, 1994) are among the first researchers who realized a systematic relationship between income growth and environmental pollution. According to their research there was an inverted U-shaped relationship between per capita income and environmental degradation as realized in original Kuznets Curve.

There has been great studies on effects and sustainable economic growth and environmental protection on each other. The main question is: is it possible to have economic development with a clean

environment at the same time? In contrast to having negative effect of economic development on environment, if one can prove that sustainable economic development can help a decent environment the countries can easily implement the necessary policies regarding the issue. The systematic relationship between income of a country and its environmental quality was first indicated by Kuznets (1955), known as Environmental Kuznets Curve and believed to have a "U" shape relationship.

Following Grossman and Krueger (1991, 1994) some other researchers have analyzed the possible relationship between the economic growth and environmental quality in different countries of the world. While some of them used panel data (Aslanidis & Xepapadeas, 2006; Grossman & Krueger, 1991, 1994; Moomaw & Unruh, 1997; Shafik & Bandyopadhyay, 1992; Tucker, 1995) some others used time series data (Cole, Rayner, & Bates, 1997; De Bruyn, van den Bergh, & Opschoor, 1998; Friedl & Getzner, 2003; Lantz & Feng, 2006; Roca, Padilla, Farré, & Galletto, 2001) to analyze the relationship.

Following, there are some studies that analyzed the relationship between economic growth and environmental quality. While some used the simple relationship between the two; some others added more variables such as the openness ratio, energy consumption and etc. to analyze the relationship.

Esteve and Tamarit (2012) modeled long-run relationship between per capita CO_2 and per capita income for the Spanish economy over the period 1857 – 2007 by using threshold cointegration techniques. According to their results there was non-linearity relationship between CO_2 and per capita income, which determines the existence of an EKC for the Spain.

Arouri et al. (2012) analyzed the relationship between CO_2 emissions, energy consumption, and real GDP for 12 Middle East and North African Countries (MENA) over 1981 – 2005 period. According to their results, energy consumption has a positive significant impact on CO_2 emissions in the long run. There was a quadratic relationship between real GDP and CO_2 emissions for the region.

Al –Mulali (2012) investigated the major factors that influence the CO_2 emission in 12 Middle Eastern countries by using panel model for 1990-2009 period. According to his results energy consumption, foreign direct investment net inflows, GDP, and total trade were important factors in increasing CO_2 emission in the countries.

He and Richard (2010) used semi parametric and flexible nonlinear parametric modeling methods to analyze and provide more robust inferences for the relationship between EKC and CO_2 in Canada. Their results show evidence in favor of the EKC hypothesis. In addition to that, they realized that the oil shock of the 1970s has had an important impact on progress towards less polluting technology and production in Canada.

Akbostanci et al. (2009) investigated the relationship between income and environmental quality for Turkey by checking the relationship between the CO_2 emissions and per capita income via time series covering 1992 – 2001 period using cointegration techniques. According to their results there was a monotonically increasing relationship between CO_2 and income in the long run. As for the second part of the study they used panel data analysis for SO_2 and PM_{10} emissions. Their results indicated an N-shape relationship between such pollutants and income.

Jalil and Mahmud (2009) examined the long-run relationship between CO_2 emissions and energy consumption, income and foreign trade for China by using 1975–2005 time series data. By using auto regressive distributed lag (ARDL) methodology they found a quadratic relationship between income and CO_2 emission, which supports EKC relationship. Their results for Granger causality tests indicate one-way causality running from economic growth to CO_2 emissions. In addition to that income and energy consumption were determinant of CO_2 emissions in the long run.

Soytas et al. (2007) tried to examine a dynamic causal relationships between carbon emissions, energy consumption, income, and foreign trade in Turkey using the time-series data covering 1960 –2005 period. By using augmented Granger causality analysis they found that the income was the most significant variable in explaining the carbon emissions in Turkey followed by energy consumption and foreign trade.

As indicated above, many studies has searched the validity of Environmental Kuznets Curve between CO_2 and some other indicators such as income per capita, energy consumption, openness ratio, foreign direct investment and etc. while some of them found a relationship that improve the validity of the curve; some other could not found such relationship to support the hypothesis of the curve. The main objective of this study is to analyze the effect of economic growth, on environment by applying EKC

approach to UAE economy.

Methodology

Annual time series data for UAE from 1970 to 2010 were taken from world development indicator database, the World Bank (2012). The real GDP was taken in US dollars according to year 2000 constant prices and converted to the per capita real GDP. Then, per capita real GDP was used as an indicator for economic growth of UAE. As for the environmental pollution, CO_2 was taken as the proxy and calculated as metric tons per capita. Per capita energy consumption was measured as kilogram of oil equivalent. The openness ratio measured as the summation of real exports and imports over real gross national product in USA dollars. The base year for monetary values was 2000=100. The human development index (HDI) is "a new way of measuring development by combining indicators of life expectancy, educational attainment and income into a composite human development index" (UNDP, 2011)

The data were organized and stationary and/or unit root statistical test procedures were utilized prior to econometric analysis. Nonstationary variables can easily be converted to stationary by simple differentiating them from their previous values. If there is a spurious problem nonstationary time-series variables should not be used in regression analysis with an exception of cointegration (Hill, Griffiths, Lim, & Adkins, 2008). The Augmented Dickey-Fuller test was conducted for both variables and differenced variables.

The long-run EKC relationship for CO_2 emission and UAE's per capita income over the 1970- 2010 period was analyzed. A log linear quadratic equation is utilized to test the long run relationship between CO_2 emission and energy consumption, economic growth, openness ratio, and human development index.

$$CO_{2_t} = \beta_0 + \beta_1 lnINC_t + \beta_2 lnINC_t^2 + \beta_3 lnE_t + \beta_4 lnOR_t + \beta_5 lnHDI_t \qquad (1)$$

Where CO_{2_t} is CO_2 emission per capita in time t, INC_t is income per capita in time t; INC_t^2 is square of income per capita in time t; E_t is energy consumption per capita in time t; OR_t is opening ratio in time t, and HDI_t is human development index in time t.

In recent decades several different cointegration model was utilized to analyze the relationship between diffrerent economic indicators and environmental pollution. There are many examples of both univariate and multivariate cointegration approaches used to analyze the relationships. Engle and Granger (1987), Ghosh (2010) are two well known examples of such studies. Recently, a single cointegration approach was developed by Pesaran et, al. (2001) and called autoregressive-distributed lag (ARDL) model. The model has become popular among the researchers. The cointegration approach, also known as bounds testing, has certain econometric advantages in comparison to other single cointegration procedures. As indicated by Pesaran et al., (2001) The advantages are: "(i) endogeneity problems and inability to test hypotheses on the estimated coefficients in the long run associated with the Engle-Granger method are avoided; (ii) the long- and short-run parameters of the model in question are estimated simultaneously; (iii) the ARDL approach to testing for the   existence of a long-run relationship between the   variables in levels is applicable irrespective of whether the underlying regressors are purely I(0), purely I(1), or fractionally integrated; (iv) the small sample properties of the bounds testing approach are far superior to that of multivariate cointegration.

The ARDL approach recently has been used by researchers such as Jalil and Mahmud (2009), Akbostanci et al (2009), Halicioglu (2009) and etc. the basic formulation of the model is as follows;

$$\Delta CO_2$$
$$= \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta CO_{2_{t-i}} + \sum_{i=1}^{p} \alpha_2 \Delta INC_{t-i} + \sum_{i=1}^{p} \alpha_3 \Delta INC_{t-i}^2 + \sum_{i=1}^{p} \alpha_4 \Delta OP_{t-i} + \sum_{i=1}^{p} \alpha_5 \Delta EN_{t-i}$$
$$+ \sum_{i=1}^{p} \alpha_6 \Delta HDI_{t-i} + \gamma_1 CO_{2_{t-1}} + \gamma_2 INC_{t-1} + \gamma_3 INC_{t-1}^2 + \gamma_4 OP_{t-1} + \gamma_5 EN_{t-1} + \gamma_6 HDI_{t-1}$$
$$+ e_t \qquad (2)$$

Where α_0 is drift component and e_t is white noise. The terms with the summation signs represent the error correction dynamics and the second part of the equation with γ indicate the long run relationship between independent variables and CO_2 emission per capita.

The cointegration approach of Pesaran et al., (2001) is recent development in time series econometrics literature. The bound testing procedure is basically based on the Fisher (F) and/or Wald- statistics and is the beginning stage of the ARDL cointegration methodology. The joint significance test that implies no cointegration hypothesis, (H0: $\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = 0$), and the alternative hypothesis, (H0: $\gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq \gamma_6 \neq 0$) should be conducted for Eq. (2). The ARDL methodology was used to analyze the long run effects of income per capita, income per capita square, opening ratio, energy consumption per capita and human development index on CO_2, which is a proxy for environmental pollution.

Results and Discussion

The descriptive statistics of the variables are given on Table 1. According to the table CO_2 emission per capita is ranged between 27.00 and 45.17 with an average value of 80. The average income per capita, opening ratio, energy consumption per capita, and human development index are $ 40906.37, 76.46, 8941.95, and 0.69, respectively.

Table 1. Descriptive Statistics

|	Minimum	Maximum	Mean	Std. Deviation
CO_2 per Capita	27.00	80.00	45.17	13.43
Income per Capita	21087.00	61375.00	40906.37	11739.26
Opening Ratio	39.00	132.00	76.46	24.96
Energy Consumption per Capita	2081.00	12608.00	8941.95	3276.86
Human Development Index (HDI)	0.53	0.85	0.69	0.09

The time trend of the variables and their first differences are given in the following figures. According to the figures both CO_2 per capita and real incomes are in decreasing trend from 1970 to 2010 period. On the other hand, opening ratio and human development index are in the increasing trend in the same period. The shape of energy consumption per capita is concave to the origin. This situation clearly shows efficient energy conservation policies of UAE government in 2000s.
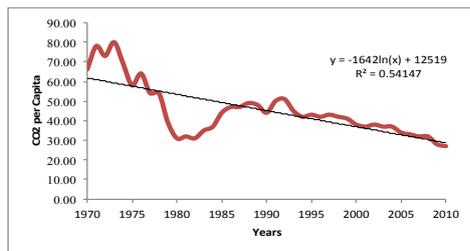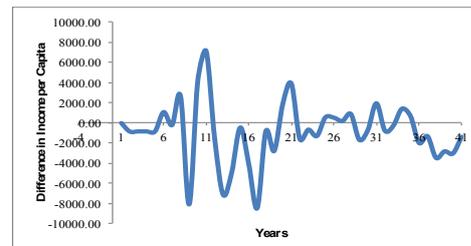

Figure 1. CO_2 per Capita (1970 – 2010)
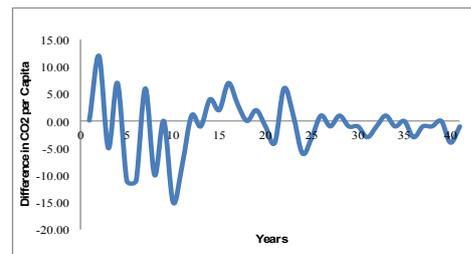
Figure 2. Difference in CO_2 per Capita (1970 – 2010)
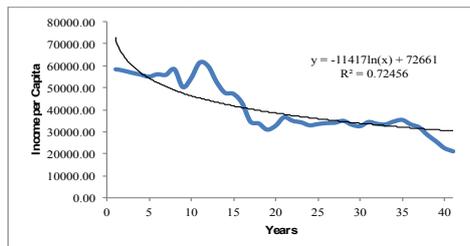
Figure 3. Income per Capita (1970 – 2010)

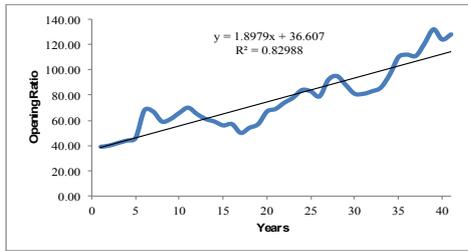**Figure 4.** Difference in Income per Capita (1970-2010)
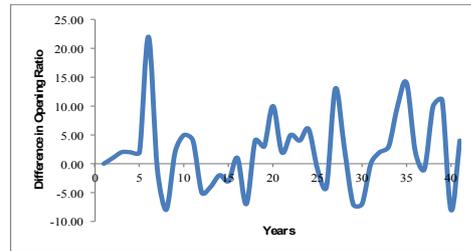
Figure 5. Opening Ratio (1970 – 2010)

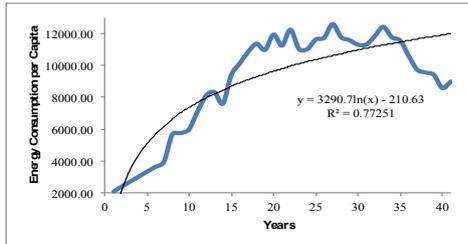**Figure 6.** Difference in Opening Ratio (1970 – 2010)

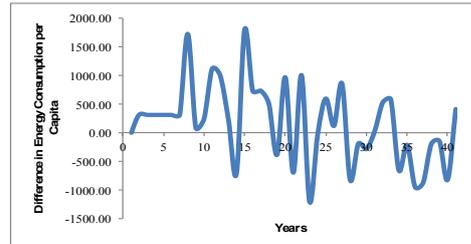**Figure 7.** Energy Consumption per Capita (1970 – 2010)

Figure 8. Difference in Energy Consumption per Capita (1970 – 2010)
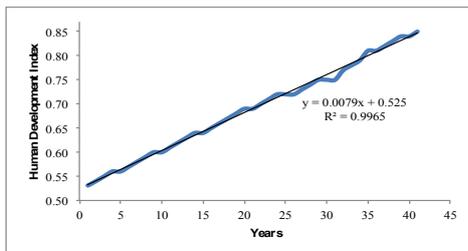

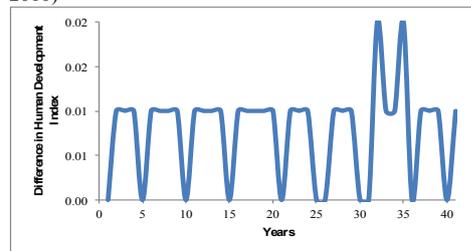**Figure 9.** Human Development Index (1970 – 2010)

Figure 10. Difference in Human Development Index (1970 – 2010)

Unit root test for the variables were checked vie augmented Dickey-Fuller unit root statistics. According to the statistics only energy variable is stationary and all others are non-stationary. After taking the first differences of the variables, as can be seen in Table 2, all variables have become stationary at 1% significance level.

Table 2. Unit Root Test

Variables	ADF	Differenced Variables	ADF
Log of CO_2	-0.109	Δ Log of CO_2	-0.865*
Log of Income	-0.011	Δ Log of Income	-0.674*
Log of Income Square	-0.013	Δ Log of Income Square	-0.686*
Log of Opening Ratio	-0.060	Δ Log of Opening Ratio	-5.165*
Log of Energy	-0.118*	Δ Log of Energy	-4.700*
Log of Human Development Index	-0.014	Δ Log of Human Development Index	-2.790*

*, represent 1% level of significance

The results of Autoregressive distributed lag model are given in Table 3. According to results only lag of CO_2 has significant negative effect on the level of CO_2 per capita. Since income has a positive effect and square of income has negative effects on the CO_2 level one can easily say that the inverted U-shape hypothesis of EKC has been detected, however the effect of the variables are not significant. All the other three variables, (opening ratio, energy consumption, and human development index) have expected negative effects on CO_2 emission. However the effect

are statistically insignificant. International trade requires environmental friendly products. That is why as import and export of the countries increases the environmental pollution is supposed to decrease. In addition that, almost all countries of the world have started to implement clean and efficient energy policies. As such policies progressed successfully then the effect of energy use on environmental degradation decreases.

Table 3. Autoregressive Distributed Lag Model Long Run Estimates

Dependent Variable LCO2

Regressors	Coefficients	*t*-Values
Lag of ln CO_2	-0.52	-2.38**
Lag of ln Income	18.33	1.31
Lag of ln Income Square	-0.89	-1.32
Lag of ln Opening Ratio	-0.18	-1.25
Lag of ln Energy	-0.17	-0.85
Lag of ln Human Development Index	-0.44	-0.47

**, represent 5% level of significance

In addition to the variables mentioned above, human development index is a good indicator of the development of the countries in education, income per capita and food safety. That is why; progress in HDI is expected to cause a decent environment for sustainable development purposes.

Conclusions

In this study we examined the relationship between income and environmental quality for UAE in order to analyze the validity of Environmental Kuznets Curve. In addition to income per capita, the square of income per capita, energy consumption per capita, opening ratio, and human development index were added to the econometric mode to see their effects on the CO_2 emission in UAE. According to the results there was an insignificant inverted-U shape relationship between CO_2 emission and per capita income. In addition to that, the lagged values of CO_2 had negative significant effect on the level of current CO_2 emission per capita. One can easily see that the level of the gas in the atmosphere of UAE is decreasing from year to year. Even though their effects on the emission are insignificant, energy consumption per capita, opening ratio, and human development index had expected negative effect on the emission level. As a result we can conclude that the economic growth, energy consumption per capita, trade and human development index in UAE are leading a decent environment, which is supporting the EKC hypothesis.

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The Evaluation of Grinding Behaviors of Quartz and Feldspar

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Abstract: Quartz crystals are used in the electronic industry, frequency control oscillator and frequency filters. Milk quartz and quartz glass by grinding and preparation procedures through the glass, detergent, paint, ceramic, sand, fill, and metallurgical industries, fine sizes (micronized) are used. Micronized feldspar group minerals, ceramics and glass industries within the limits of a certain quality have an important market due to the grinding of raw materials are widely used. In the size reduction, energy-intensive process is consumed about 3% of the energy produced in the industrialized countries in the world (Schonert, 1979; Narayanan, 1987). The size reduction operations are spent on approximately 55-70 % of the total energy consumed in the mineral processing plants (Cohen, 1983; Lynch et al., 1986). In this study, the behavior of quartz and feldspar broken into the same grinding conditions was presented Bond Grinding test and then analyzed using the kinetic model. The results obtained experimental works in each of two methods is compared.

Keywords: Kinetic Model, Breakage Rate, Industrial Raw Materials

Introduction

Quartz is the second most abundant mineral in the Earth's continental crust. There are many varieties of quartz, which occurs in nearly all types of igneous, metamorphic and sedimentary rocks. Hence, it found as a main impurity in all kinds of valuable ore deposits.

Regular and clean quartz crystals are used in optical and electronic industry and the ornamental stone. Quartz crystals fine grinding are used in the electronic industry, frequency control oscillator and frequency filters. The grinding of quartz and milk quartz are finely ground and are been mineral preparation used for glass, detergents, paints, ceramics, sand, fill, and metallurgical industries.

The largest consumption areas of feldspar produced in Turkey have been ceramic, glass industries, painting, welding electrodes and plastic industry. The biggest challenge in producing K-Feldspar is due to the production of glaze K-Feldspar and grinding of the K-Feldspar. This is a fact that the coming years will be even more important. In particular, as the productions of granite - ceramic with natural ceramics in factories are passed, Production of K-feldspar require to excusive grinding preparation.

The demand for fine, or ultrafine particles is increasing in many industries. The energy required for the size reduction increases with a decrease in feed or produce particle size, and research and development to find energy-saving size reduction processes have been performed for years.

For all dry grinding applications, chemical industries, mineral industries and cement production are certainly the most important. Energy necessity is very high in grinding processes. There are many grinder manufactures and several of machines made for grinding minerals. The correct selection between all alternative is a difficult problem (Deniz, 2011 & Deniz, 2011)

In the design of grinding circuits, the Bond method is widely used to evaluate the performance and to determine the powder required and mill size for a material. This method is complex and takes a very long time. In addition to this, it is very sensitive to procedural errors. For this reason, many investigators have proposed alternative methods to the Bond method (Deniz, Özdağ, 2003; Deniz, 2004).

In the recent years, matrix and kinetic models have been used in the laboratory and in the industrial areas. Kinetic model, an alternative approach, considers comminution as a continuous process in which the rate of breakage of particles size is proportional to the mass presented in that size (Deniz, Onur, 2002).

The analysis of size reduction in tumbling ball mills using the concepts of specific rate of breakage and primary daughter fragment distributions have received considerable attention in recent years. Austin (1972) and

Austin et al. (1984) reviewed the advantages of this approach, and the scale-up of laboratory data to full-scale mills has also been discussed in a number of papers.

In this study, the behaviors of quartz and feldspar comminution in the same grinding conditions are investigated that firstly Bond Grinding test and then analyzed using the kinetic model. Results of both methods are compared.

Theory

1. Kinetic Model

Population balance modeling is a widely used tool for the quantitative analysis of comminution processes at the process length scale. The traditional size-discrete form of the population balance equation for batch comminution is linear and assumes first-order breakage kinetics (Austin, 1972).

$$\frac{dw_i(t)}{d_t} = -S_i W_i(t) + \sum_{j=1}^{i-1} b_{ij} S_j W_j(t), \tag{1}$$

Thus, the breakage rate of material that is in the top size interval can be expressed as:

$$\frac{-dw_1}{dt} = S_1 w_1(t) \tag{2}$$

Assuming that S_1 does not change with time (that is, a first-order breakage process), this equation integrates to

$$\log(w_1(t)) - \log(w_1(0)) = \frac{-S_1 t}{2.3} \tag{3}$$

where $w_1(t)$ and is the weight fraction of the mill hold-up that is of size 1 at time t and S_1 is the specific rate of breakage. The formula proposed by Austin et al. (1984) for the variation of the specific rate of breakage S_i with particle size is

$$S_i = a_T X_i^{\alpha} \tag{4}$$

where X_i is the upper limits of the size interval indexed by i, mm, and a_T and α are model parameters that depend on the properties of the material and the grinding conditions.

On breakage, particles of given size produce a set of primary daughter fragments, which are mixed into the bulk of the powder and then in turn have a probability of being refractured. The set of primary daughter fragments from breakage of size j can be represented by $b_{i,j}$, where $b_{i,j}$ is the fraction of size j material, which appears in size i on primary fracture, $n \geq i > j$. It is convenient to represent these values in cumulative form.

$$B_{i,j} = \sum_{k=n}^{i} b_{k,j} \tag{5}$$

where $B_{i,j}$ is the sum fraction of material less than the upper size of size interval i resulting from primary breakage of size j material: $b_{i,j} = B_{i,j} - B_{i+1,j}$. Austin et al.(1981) have shown that the values of $B_{i,j}$ can be estimated from a size analysis of the product from short time grinding of a starting mill charge predominantly in size j (the one-size fraction BII method). The equation used is,

$$B_{i,j} = \frac{\log\left[(1 - P_i(0))\right]/\log\left[(1 - P_i(t))\right]}{\log\left[(1 - P_{j+1}(0))\right]/\log\left[(1 - P_{j+1}(t))\right]} \cdot \quad n \geq i \geq j+1 \tag{6}$$

where $P_i(t)$ is the fraction by weight in the mill charge less than size X_i at time t. $B_{i,j}$ can be fitted to an empirical function (Austin and Luckie, 1972).

$$B_{i,j} = \phi_j\left[X_{i-1}/X_j\right]^{\gamma} + (1-\phi_j)\left[X_{i-1}/X_j\right]^{\beta} \quad n \geq i \rangle j \tag{7}$$

where

$$\phi_j = \phi_1\left[X_i/X_1\right]^{-\delta} \tag{8}$$

where δ, ϕ_j, γ, and β are model parameters that depend on the properties of the material. If $B_{i,j}$ values are independent of the initial size, i.e. dimensionally normalizable, then δ is zero (Austin et al., 1984).

2. Bond Grindability Test

Laboratory Bond grindability tests were conducted with -3.35 mm dry feed materials in a standard ball mill (30.5 x 30.5 cm) following a standard procedure outlined in the literature (Yap et al., 1982; Deister, 1987; Ipek, 2003). The BWI was determined at a test sieve size of 106 μm. Mill has no lifters and all the inside corners are rounded. It is operated at 70 rpm and is equipped with a revolution counter. The grinding charge consists of 285 iron balls weighing 20.125 grams with a calculated surface area of 842 inc^2.

The standard Bond grindability test is a closed-cycle dry grinding and screening process, which is carried out until steady state conditions are obtained. This test was proposed by Bond and Maxson (1943) and used by different researcher (Yap et al, 1982; Austin and Brame, 1983; Magdalinovic, 1989). The material is packed to 700 cm^3 volume using a vibrating table. This is the volumetric weight of the material to be used for grinding tests. For the first grinding cycle, the mill is started with an arbitrarily chosen number of mill revolutions. At the end of each grinding cycle, the entire product is discharged from the mill and is screened on a test sieve (P_i). Standard choice for P_i is 106 micron. The oversize fraction is returned to the mill for the second run together with fresh feed to make up the original weight corresponding to 700 cm^3. The weight of product per unit of mill revolution, called the ore grindability of the cycle, is then calculated and is used to estimate the number of revolutions required for the second run to be equivalent to a circulating load of 250%. The process is continued until a constant value of the grindability is achieved, which is the equilibrium condition. This equilibrium condition may be reached in 6 to 12 grinding cycles. After reaching equilibrium, the grindability for the last three cycles is averaged as a Bond grindability index (G_B).

The products of the total final three cycles are combined to form the equilibrium rest product. Sieve analysis is carried out on the material and the results are plotted, in order to find the 80% passing size of the product (P_i). The coal samples are crushed by a laboratory scale jaw crusher and the standard Bond grindability test were performed in the laboratory. BWI values are calculated from Equation 1. G_B and BWI values are presented in Table 2.

$$\text{BWI} = 1.1\frac{44.5}{P_i^{0.23}G_B^{0.82}\left(\dfrac{10}{\sqrt{P_{80}}} - \dfrac{10}{\sqrt{F_{80}}}\right)} \tag{9}$$

where W_i is Bond work index in kWh/t, P_i is sieve size at which the test is performed in μm, G_B is Bond's standard ball mill grindability in g/rev, P_{80} and F_{80} are sieve opening at which 80% of the product and feed passes, respectively in μm.

Materials and Method

The samples taken from different regions of Turkey were used as the experimental materials. Feldspar, quartz samples are taken from deposits in Aydın – Çine in Turkey.

Materials were broken -3,36 mm for grinding tests. The standard set of grinding conditions used was shown in Table 1. Ten mono-size fractions (-3,35+2,8;-2,8+1,7;-1,7+1,18; -1,18+0,850; -0,850+0–600; -0,600+0,425; -0,425+0,300; -0,300+0,212; -0.212+0,150; -0,150+0,106 mm) were prepared and ground batch wise in a laboratory-scale ball mill for determination of the breakage functions. Samples were taken out of the mill and dry sieved product size analysis.

Table 1: The standard set of grinding conditions

	Diameter	200 mm
	Length	200 mm
Mill	Volume	6283 cm^3
	Critical speed (Nc)[a]	101 rpm
	Operational (75, %)	78 rpm
	Diameter range	25.4 mm
	Specific gravity	7.8 g/ cm^3
Bilya	Quality	Alloy steel
	Assumed bed porosity	40%
	Ball filing volume (J%)[b]	30% (J=0,3)
Material	Feldspar	Quartz
Formal bulk density, g/cm^3	2,61	2.64
Interstitial filling (U%)[d]	0,83	0.83
Powder filling volume (f_c%)[c]	0.10	0.10

[a] *Calculated from Nc=42.3 /√D-d (D, d in meters)*

[b] *J=[(mass of balls / specific gravity of balls)/ mill volume] *1/ 0.6*

[c] *f_c=[(mass of materials / specific gravity of materials)/ mill volume]*

*U= f_c / 0,4*J*

Results and Discussion

1. Determination of Bond Grindability and work index

First, standard Bond grindability test was made for feldspar and quartz samples. Bond grindability and index values were given table 2.

Table 2: Grindability and work index values of feldspar and quartz

Samples	G_{bg} (g/r)	W_i (kwh/t)
Feldspar	2,30	9,81
Quartz	1,29	16,10

2. Determination of S Functions

The first-order plots for the various feed sizes of all samples and for the various feed sizes of samples were made. Typical first-order plots for grinding of all samples, at a low powder load corresponding to a formal interstitial filling of the void spaces of the ball bed of U% 0.83. The results indicated that breakage generally followed the first-order relation and values of Si could be determined. As a function of size, the values of Si were given figure 1 and figure 2. Parameters of specific rate of breakage to supply by first-order plots are presented in Tables 3.

Table 3: Model parameter values for quartz and feldspar

Samples	a_t	α	γ	ϕ_J
Quartz	0.88	1.52	1.59	0.45
Feldspar	0.33	1.14	0.65	0.49

The greater the amount of Si and a_T values, the more effective breakage and the faster broken in the undersize of original particle size. From the Table 3, it is seen that quartz was broken faster than feldspar in terms of the a_T values. On the contrary, the Bonds grindability value (G_{bg}) for feldspar was easier than quartz.
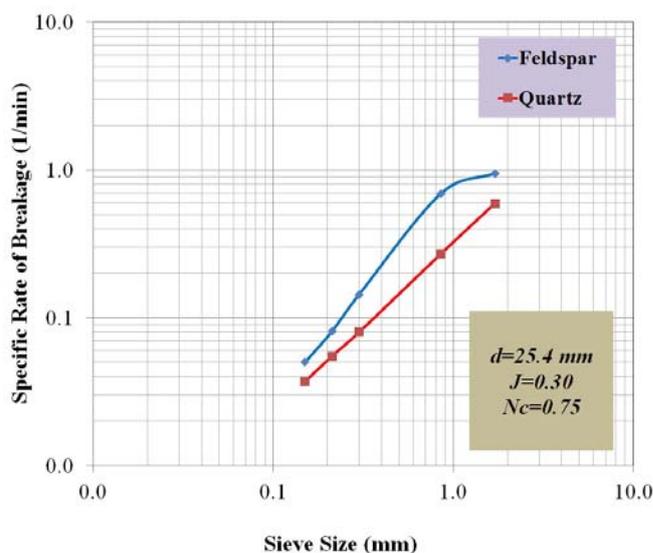

Figure 1: Specific rates of breakage for quartz and feldspar

3. Determination of B Functions

Determination of *B* Functions by definition, the values of *B* were determined from the size distributions at short grinding times. The parameters were determined according to the *BII* method (Austin et al. 1984), and are shown as graphical representations in Figures 2.

All samples show a typical normalized behavior, and the progeny distribution did not depend on the particle size, and it followed that the parameter δ was zero. Model parameters supply by cumulative distribution and these parameters are presented in Tables 3.
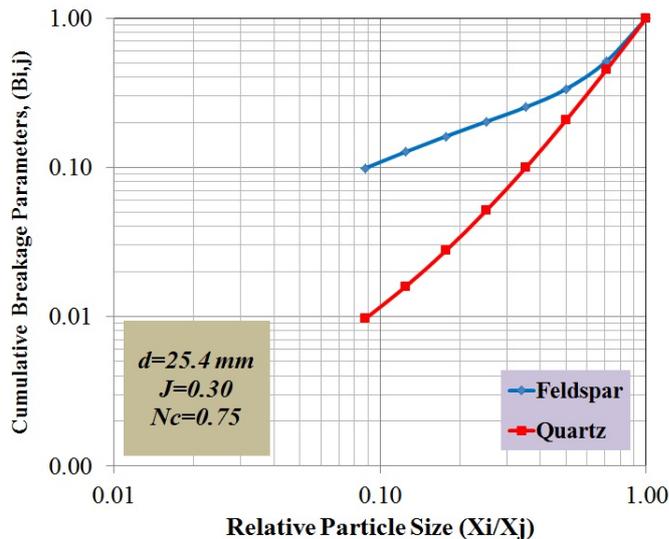

Figure 2: Cumulative breakage distribution functions of quartz and feldspar

The slope of the lower portion of the $B_{i,j}$ curve can be denoted by χ with smaller values of χ and indicating that once particles of a certain size break, they produce many much smaller progeny fragments. Thus, feldspar samples produce finer material than quartz by considering the χ value of $B_{i,j}$. The values of the coefficient ϕ_j is related to coarse end of the breakage distribution function and show how fast fractions close to the feed size passes to smaller size interval. The ϕ_j value (0.49) was higher for Feldspar than other samples indicating that acceleration in the breakage of the top size for feldspar and deceleration for quartz (0.45).

Conclusions

Bond grindability test gives information about the materials of strength to grindability and comminution and helps us to determine energy consumption, in the selection of crushing equipment.

Bond grindability values of two samples are obtained 1.29 g /rev of quartz and 2.30 g/rev of feldspar. In addition, Bond Work Index for each of two samples is calculated 10.16 kWh / t of quartz and 9.81 kWh / t for feldspar, respectively. Grindability of feldspar is easier than quartz from grindability and Bond work index values.

In the experimental study of Austin et al (1984), is appeared that if Si values are being high particulates will be more efficient break and the original particulate can be reduced more quickly reported. According to this approach, feldspar is broken faster than quartz.

γ, ϕ_j values is provide information that large quantity or low quantity of amount of fine material and coarse sieve size to fine sieve size gives an idea about the breakage rate. The materials are to be grinding more quickly from high of these values. According to this approach it was emerged feldspar was ground faster than quartz.

In the grinding studies depend on Bond grindability and kinetic model, it was showed that grinding of feldspar and quartz samples is a similar trend. In the previous studies on Bond grindability values and kinetic model parameters were not observed similar trends.

In the study of Deniz (2011), Bond grindability values and kinetic model parameters were emerged a different behavior. In this study, the kinetic model parameters on grindability of materials that is difficult appeared a similar trend.

Key Terms:

J	fraction of mill volume filled by the ball bed
fc	fraction of mill volume filled by the powder bed
U	fraction of the interstices of the ball bed filled by powder
d	ball diameter (mm)
W	total powder mass in the mill
t	grinding time (min)
$w_1(t)$	weight fraction of mill hold-up that is of size 1 at time t
i	an integer indexing a $\sqrt{2}$ screen interval
Si	specific rate of breakage (min^{-1})
Xi	the upper limits of the size interval indexed by i (mm)
aT	model parameter
α	model parameter
bi,j	breakage distribution function, part of interval j falling into interval i
Bi,j	cumulative breakage distribution function
$P_{i(0)}$	cumulative weight fraction at time 0 for size interval i
$P_{i(t)}$	cumulative weight fraction at time t for size interval i
χ	model parameter
β	model parameter
φ_j	model parameter
δ	model parameter

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