European Journal of Scientific Research

Publication Ethics and Publication Malpractice Statement

Duties of Editors

Confidentiality— Editors of the journal must treat received manuscripts for review as confidential documents. Editors and any editorial staff must not disclose any information about submitted manuscripts to anyone other than the corresponding author, reviewers, other editorial advisers, and the publisher.

Equal Treatment—Editors of the journal must evaluate manuscripts for their intellectual content and their contribution to specific disciplines, without regard to gender, race, sexual orientation, religious belief, ethnic origin, citizenship, or political philosophy of the authors.

Disclosure and Conflicts of Interest— Editors of the journal and any editorial staff must not use materials disclosed in a submitted manuscript (published or unpublished) for their own research without the author's written authorization.

Integrity of Blind Reviews—Editors of the journal should ensure the integrity of the blind review process. As such, editors should not reveal either the identity of authors of manuscripts to the reviewers, or the identity of reviewers to authors.

Publication Decisions—Editors of the journal are responsible for deciding which of the manuscripts submitted to the journal should be reviewed or published. However, editors may consult other editors or reviewers in making such decisions.

Cooperative involvement in investigations—Editors of the journal should conduct a proper and fair investigation when an ethical complaint (concerning a submitted or published manuscript) is reported. Such process may include contacting the author(s) of the manuscript and the institution, giving due process of the respective complaint. If the complaint has merits, a proper action should be taken (publication correction, retraction, etc.). Besides, every reported action of unethical publishing behavior should be investigated even if it is discovered years after publication.

Duties of Reviewers

Confidentiality—Reviewers must consider all received manuscripts for review as confidential documents. Received manuscripts must not be seen by or discussed with others, except as authorized by the journal editors or authorized editorial staff.

Objectivity—Reviewers should conduct their reviews objectively. Criticism of the author's personality or the topic is unprofessional and inappropriate. Reviewers should explain their recommendations clearly and explicitly and provide rational support and justification. Editors Recommendations could be one of the following:

• Accept the publication of the manuscript after compliance with the reviewers' recommendations.

• Consider the publication of the manuscript after minor changes recommended by its reviewers.

• Consider the publication of the manuscript after major changes recommended by its reviewers.

• Reject the publication of the manuscript based on the reviewers' recommendations

Fast-Track Reviews—Reviewers are requested to complete their reviews within a timeframe of 30 days. Reviewers also are free to decline reviews at their discretion. For instance, if the current work load and/or other commitments make it impossible for reviewers to complete fair reviews in a short timeframe (e.g., few days for fast-track review), reviewers should refuse such invitations for review and promptly inform the editor of the journal.

Qualifications—Reviewers who believe that they are not qualified to review a received manuscript should inform the journal editors promptly and decline the review process.

Disclosure—Information or ideas obtained through blind reviews must be kept confidential and must not be used by reviewers for personal benefits.

Conflict of Interest —Reviewers should refuse the review of manuscripts in which they have conflicts of interest emerging from competitive, collaborative, or other relationships and connections with any of the authors, companies, or institutions connected to the manuscripts.

Substantial Similarity—Reviewers should inform editors about significant resemblances or overlap between received manuscripts and any other published manuscripts that reviewers are aware of.

Proper and Accurate Citation —Reviewers should identify relevant published work that has not been cited by the authors. Statements that include observation, derivation, or argument (currently or previously reported) should be accompanied by a relevant and accurate citation.

Contribution to Editorial Decisions—Reviewers assist editors in making editorial publication decisions, and also assist authors in improving their submitted manuscripts, through the editorial communications with authors. Therefore, reviewers should always provide explicit and constructive feedback to assist authors in improving their work.

Duties of Authors

Originality—Authors submitting manuscript to the journal should ensure that this submission is original work and is neither currently under consideration for publication elsewhere, nor has been published as a copyrighted material before. If authors have used the ideas, and/or words of others researchers, they should acknowledge that through proper quotes or citations.

Plagiarism—Plagiarism appears into various types, such as claiming the authorship of work by others, copying and paraphrasing major parts of others research (without attribution), and using the results of research conducted by other researchers. However, any type of plagiarism is unacceptable and is considered unethical publishing behavior. Such manuscripts will be rejected.

Authorship of Manuscripts—Authorship of a manuscript should be limited to authors who have made significant contributions and the names of authors should be ranked by efforts. The corresponding author must ensure that all listed coauthors have seen and approved the final version of the manuscript (as it appeared in the proofreading copy) and agreed to its publication in the journal. Authors can permit others to replicate their work.

Multiple or Concurrent Publication— Authors should not publish manuscripts describing essentially the same research in more than one journal. Submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behavior and is unacceptable. This action leads to the rejection of the submitted manuscripts.

Acknowledgement of the Work of Others—Authors should always properly and accurately acknowledge the work of others. Authors should cite publications that have significant contribution to their submitted manuscripts. Unacknowledged work of others contributing to manuscripts is unethical behavior and is unacceptable. Such manuscripts will be rejected.

Reported objectives, discussions, data, statistical analysis, and results should be accurate. Fraudulent or knowingly inaccurate results constitute unethical behavior and are unacceptable. Such manuscripts will be rejected.

Data Access and Retention— Authors may be asked to provide the raw data in connection with manuscripts for editorial review, and should be prepared to provide public access to such data if possible. However, such authors should be prepared to retain data for a reasonable time after publication.

Hazards and Human or Animal Subjects— If a research study involves chemicals, procedures or equipment that have any unusual hazards inherent in their use, the author(s) must clearly identify these in the submitted manuscript. Authors should also inform participating human subjects about the purpose of the study.

Conflicts of Interest— In their manuscript(s), authors should disclose any financial or other substantive conflict of interest that might influence the results or interpretation of their manuscript.

Copyright of Accepted Manuscripts—Authors of accepted manuscripts for publication in the journal agree that the copyright will be transferred to journal and all authors should sign copyright forms. However, those authors have the right to use of their published manuscripts fairly, such as teaching and nonprofit purposes.

Substantial errors in published Manuscripts—When authors discover substantial errors or inaccuracy in their own published manuscripts, it is the authors' responsibility to promptly inform the journal editors or publisher, and cooperate with them to correct their manuscripts.

Acknowledgement of Indirect Contributors and Financial Supporters—Authors should acknowledge individuals whose contributions are indirect or marginal (e.g., colleagues or supervisors who have reviewed drafts of the work or provided proofreading assistance, and heads of research institutes, centers and labs should be named in an acknowledgement section at the end of the manuscript, immediately preceding the List of References). In addition, all sources of financial support for the research project should be disclosed.

Disclaimer
Neither the editors nor the Editorial Board are responsible for authors' expressed opinions, views, and the contents of the published manuscripts in the journal. The originality, proofreading of manuscripts and errors are the sole responsibility of the individual authors.

All manuscripts submitted for review and publication in the journal go under double-blind reviews for authenticity, ethical issues, and useful contributions. Decisions of the reviewers are the only tool for publication in the journal and will be final.

European Journal of Scientific Research

Contents

A New Method to Locate License Plate in Color Images

Maha Ghayem
Department of Electrical Engineering, Faculty of Engineering
Shahid Chamran University, Ahwaz, Khuzestan, Iran
E-mail: maha.ghayyem@gmail.com

Abstract

Recently, researches widely have been done for license plate recognition and many systems have been also provided to recognize the various license plates. These systems used for many activities such as traffic control and public parking and many others applications. Three main steps for license plate recognition are; to recognize the location of license plate, to separate and recognize the characters. Also, there are some problems for license plate recognition by new methods such as low quality, intense lighting, imaging angular, different distance between camera and automobile, complex background and etc. In this article, a new method proposed to locate license plate. The performance of proposal method is more than similar methods, because in this method no high costs has been used for image processing operations. The characteristics of this method include; high processing and performance, ability to install and run on microprocessors, ability to recognize several license plates for an image and processing on color image without size shifts. Its operational performances are such as issuing electronic fines; create intelligent system to pay complications; controlling tunnels, highways, parking, traffic control plan and etc. In order to reduce these items in this article a blue band has been used besides the license plate of Iranian vehicles as well as a type of color edge detection led to recognize the location of plate by an innovative thresholding. This method is examined in different status and the results are presented. Proposed method in comparison with other methods involved high accuracy. The results of desired data from images of speed control cameras in highways emphasized performance, accuracy, reliability and speed of the proposed system, hence its high accuracy obtained through several experiments.

Keywords: License plate searching, color edge detection, color analysis and morphology, pattern recognition.

1. Introduction

Intelligent recognition of license plate in color images plays an important role for many applicable programs and several methods have been suggested. There are some different factors to recognize the license plate such as fog, rain, plate angular and etc. These factors can lead to complexity of the license plate recognition. License plate recognition is mechanized completely is able to recognize the license plate by processing the image of vehicles passing through a location. This method is not required to install and equip the vehicles by others such as GPS. Special cameras are used to take a photo from passing vehicle and send the image to computer for processing by LPR software. This system also used for security and traffic control. Some non-appropriate algorithms are applied for LPR. The location of license plate is recognizing after the stages and the angle that is parallel to the plaque location obtained by an algorithm, finally the desired license plate will be rotated. But, some factors such as too dirty

plates and ambiguous white background of them are known as problems of this algorithm to recognize the location of license plate. Extreme complexity of this method caused for some limitations and confusion for the programs or image processing and considering all items is not proper suggestion. Various methods are provided for LPR in image processing such as color [1], edge finder [2], morphology operators [3], and Hugh Transform [4]. With the methods based-color, color may be changed and lost its stability, if the lighting changed. Color license plates are required for processing times more than gray license plates. The advantage of edge detection is related to its removal speed and simplicity. This method is not used alone and recognizes many of points outside the license plate as license plate. In Hugh Transform first input edges of image are obtained, then Hugh Transform is used for LPR. The results will be favorable if images are confined. But, this method is sensitive to change the plate boundaries led to more processing. Another method is Fuzzy Logic [5] with some intuitive rules to describe the plate location. This method is sensitive to color and light of license plate and more processing than the method based-color is essential.

2. Related Works

The location of license plate should be clear to recognize its accurate, exact and fast of. So, techniques of license plate recognition will be discussed in this research. Generalized symmetry transformation and detection the image edges in reference [12] are used to recognize and normalize the license plate. Also, in reference [19] multi-layer pioneer neural Network is used for recognition the location of license plate (this method is not usable because of such problems such as low speed and restriction on the size of plate). Both mentioned methods are used for such images merely with an automobile and without complex background. According to reference [15], PCNN, statistical methods, and detection of shape edges are used to find the location of license plate. This method included three characteristics. First, the image is static. Second, a plate just arises from an image. Third, it is difficult to provide a plate from images with complex background. Many applications are used for some images with complex background. It is very difficult to provide several plates from an image with complex background. There is a method by reference [16] to provide a plate from images with complex background. In this reference, the value of threshold is determined to improve the quality of plate by applying image histogram equalization technique. So the image quality is improved, different pixels estimated in every major region and dilation technique used to smooth the edge of shapes. Finally, the ratio of width to length and the ratio of black pixels are estimated and deleted from the regions with no plate. So, the image of plates is returned as output. In this article, the location of plate is assumed near the middle of image and it is difficult to provide it if the plate located insides the image. The accuracy in this article estimated about 80.7%. In reference [17], TDNN is used to determine the location of license plate. It is very interesting, innovative and powerful method and its use is recommended. According to references [11&12], horizontal - vertical scanning technique of image is used based on the difference in brightness of the image in the location of plate. The methods are considered in two recent articles are very accuracy, explicit, simple, and powerful. But, in this article a matched method (but not similar) will be used. In reference [13], isolation strategies are estimated by a model, clustering, edge detection, and growth the region. Reference [10] suggested to use presupposes knowledge about license plate especially about unique plates. Also, Valley technique is used in this reference between characters based on vertical histogram, as well as eliminating the redundant parts of plate located on upper and lower by horizontal histogram. In reference [12], a vertical-horizontal scanning technique and a algorithm in association with the viral replication have been used to separate the characters. In reference [21], increasing the size of image as inputs to the neural network can lead to improve the learning process, because details of the model will be more visible. In reference [22], genetic algorithm (GA) is used to recognize the features of Persian letters. In reference [10], pattern matching method is suggested to recognize the characters. In this method, various different patterns such as image of each characters, vertical-horizontal histogram, and etc, have been saved for each character in database. With visual words recognition, the researchers often used neural networks in

order to achieve the goals. Neural network involved proper features for pattern recognition include ability to adapt to different situations and recognize new patterns has not been encountered previously. Hence, different neural networks have been proposed and some of them will be presented as following. In reference [11], constraint-based decomposition (CBD) is used to recognize the license plate characters. CBD is modified algorithm included three parts; weight modification rule (each algorithm that is able to learn a single layer network); a algorithm to present a model; and a method for network codification. In this technique solving problem and learning are done simultaneously. According to reference [12] and more other articles, a pioneer multilayer neural network (multilayer perceptron - MLP) is used based on learning standard rule if learning and recognizing the letters and words in different languages encountered to the error. In reference [24], various techniques such as statistical analysis and probabilistic neural network (PNN) 20 times faster than similar algorithms are used to recognize handwritten forms. In reference [23], artificial neural network of MLP and learning standard rule and Hidden Markov chain simultaneously are used to recognize Arabic alphabets with different fonts such as Diwani, Ahada, Kufi and Badr. In reference [25], both techniques based-neural rules and networks, and experts systems are used to develop intelligent system for handwritten recognition.

3. Proposed System
3.1. Rotate the Angled Image

In this regard, a algorithm is used to obtain central gravity of all numbers and then the central gravity of both first and last numbers are considered as the basis and after achieving to connecting line between central gravity of first and last numbers based on horizon line, all license plate numbers will rotate in the opposite direction as shown by figure (1).

Figure 1: Rotate the image

3.2. Recognize the Location of License Plate in Color Space of HSV

If pixels within the variables H are greater than 50 and less than 70, they are blue based on Color Map in color space of HSV. If pixels are greater than 50 and less than 70 and lighting is greater than 40 and less than 75, blue pixel is similar to color of plate location. If 10 pixels are located in a line together with above characteristics, the location of selected pixels involves 95% of license plate in image.

3.3. Recognize the Location of License Plate in Color Space of HSV by Mosaic Image

First, a color image transfer to color space of HSV. The image divide into Mosaic by pixels 15*15 and provide a list of Mosaics are ready for processing and probability will select in next stages. Each Mosaic probability is selected based on its position and probability to select the middle Mosaics and lower than it is more, but probability the upper and lateral Mosaics is less.

Figure 2: The Mosaic image of an automobile
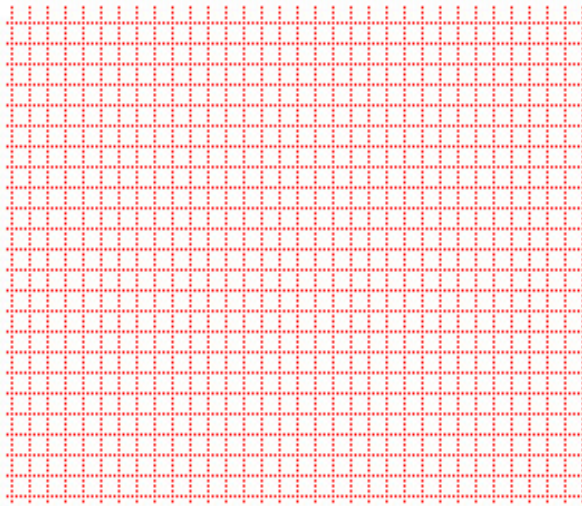
So, Mosaics randomly are examined through a iterative process and probability distribution for each Mosaic with 58 pixels. All Mosaics examined by observing a blue pixel, and height of the blue continuous location as candidate height for license plate will be obtained if upper and lower Mosaics examined. According to standard, if the height of license plate is greater than 8, its width will obtain. The validation procedure done through achieving to the license plate candidate coordinates. Color of background and permitted variations color for license plate in horizontal direction are important. Permitted colors for background and characters are respectively red and white, yellow and black, and white and black. Amount of thresholds color variations is about 10. Because standard license plates are about 8 characters, and input and output are occurred once for each character (i.e, 16 times). Also, it is possible to locate part of license plate in desired candidate area because of angled license plate, hence 10 is better than 16. Therefore, the area may be known as license plate if the color variations are greater than 10 times. Desired Mosaics for processing are examined and extracted. This process will be done to examine all Mosaics. The worst case occurs when there is no plate in picture, and may damage which makes it impossible to detect. In this regard, all Mosaics will be examined and 21.15 % of image will be processed. According to many researches, this processing requires to 1.5 seconds. But, if license plate is visible in picture just 40% of Mosaics will be examined, i.e, only processing of 8.46% of image and needs to 0.9 seconds.

3.4. Color Edge Detection Based on Columnar Scanning

It is very time consuming and costly to find an object in a picture. According to common methods are used for pattern recognition, the image scanned sliced and pixel by pixel, the pattern compared with main image and the error will be examined in all of image and the location with less error will be presented. But, this process is time-consuming with high overload in processing. So, new solution with super high speed in scanning and searching without dependency (like object and pattern) presented to find an object in main image. In this regard, it is possible to bring image in 8 main color of RGB cube or other color spaces such as HSV or Lab and scanned periodically from top to down. The columnar scanning is shown by figure (3). As can be seen in figure, this process will be presented as a probability and as a candidate for the location of license plate if it reached to blue, and also the pixels covered with green, white and red by both their width and numbers equally, and again reached to blue color and background with 11 times over than one of the flag colors or 11 times over than primary blue background.

Figure 3: Columnar scanning to find blue band of national license plate
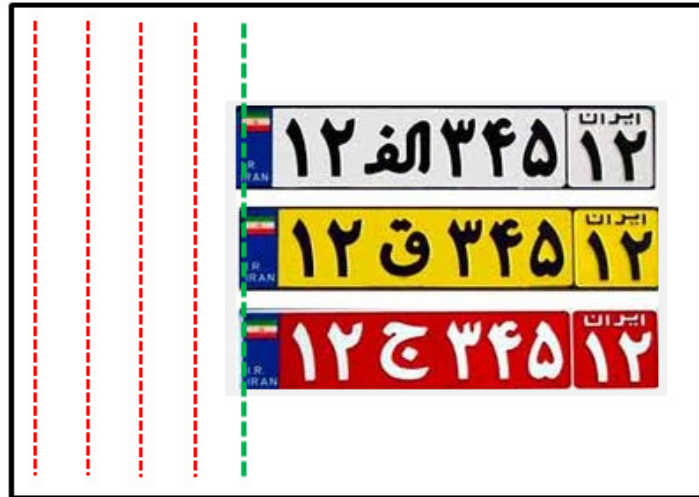
3.5. Edge Detection Based on Morphology

In this article the variations of light intensity will be used in the location of license plate. According to proposed method [11,12], row-columnar scanning of automobile image and the number of variations in color levels to find the location of license plate does not work well for angled license plates. Because the variations of color level in the corner of image is less than the threshold (for example, about 16 variations for each row) led to remove part of license plate. So, the rows are considered as a part of location for plate candidate if the variations of light intensity in rows are less than the threshold and their upper and lower rows is not less than the threshold. Some noises relied on candidate of license plate based on their rows possible to consider as part of license plate and lead to improve the technique and increase final noises derived from image. This problem will be solved by examining the image histogram and searching its valley in order to find columnar continuity of license plate characters (Reasonable distances of license plate characters), and eliminate discontinuous objects (Unreasonable distances). However, some parts of automobile picture will be examined as part of a candidate for license plate because recent features provided over than 15 rows. For the location of license plate each probable candidate need to examine by its validity. So, additional shapes of picture which are not used as part of plate characters should be eliminated. These shapes are such as length, width, area, the ratio of black and white points, and the comparison of these parameters with Mode parameters [15,16]. (it is obvious that the points and vowels of letters will be eliminated). Then, current candidate will be accepted or rejected after the figures in picture accounted and the angular of license plate determined (through determine the slopes of Mode figures to each other). If there are less than 7 figures in picture and the angle of license plate is less than absolute magnitude down to about +30, the location is known as a candidate.

3.6. Edge Detection Based on Lighting

Edge refers to the rather different line between locations and properties of gray level. For many edge detection methods, basic theory is related to examine a local derivative operator. It is possible to determine pixel is located on edge or not if first derivation magnitude is presented, and second derivative presented the pixel is located on dark or light edge. Second derivative crossed the zero in midpoint of each edge and led to determine the location of image edges. In image, size of first derivative for each point is equal to the size of two-dimensional Gradient function. Second derivative is obtained by Laplacian. If the variation of lighting intensity is sharp in image edge and its noise is less, edge detection and Gradient operators may have proper performance sometimes. Also, if the edges are opaque or noise levels are high, crossing the zero is better alternative way.

3.7. Color Edge Detection for Various License Plate

This edge detector should be sensitive to three edges include white-dark, yellow- black and red-white. Assume a white- black edge and color input image of RGB is normalized to color rgb. So, values of (r,g,b) for white and dark pixels respectively are (1.3,1.3,1.3) and (0,0,0). Hence, their differences are (1.3,1.3,1.3) or (-1.3,-1.3,-1.3) and are constant in environmental shifts. If the signs of components of the difference vector of the pixel are equal to one of its neighbors, an image pixel will be shown as white-black edge.

$\text{Sign}(\Delta r_i) = \text{sign}(\Delta g_i) = \text{sign}(\Delta b_i), i \epsilon N$

N refers to the neighbors of pixel i and the size of edge is defined as min $\{|\Delta r_i|, |\Delta g_i|, |\Delta b_i|\}$. Similarly, an edge is considered as red-white and its different vector is $(\Delta r_i\ \Delta g_i\ \Delta b_i)$ and following condition is required addition to above equations:

$|\Delta r_i| < |\Delta b_i|, |\Delta r_i| < |\Delta g_i|$

And the size of edge is known as min$\{|\Delta g_i|, |\Delta b_i|\}$. Finally, addition to above equation, following condition has been suggested for yellow-black edge in this article:

$|\Delta r_i| > |\Delta b_i|, |\Delta b_i| = |\Delta g_i|$

And the size of edge is equal to $|\Delta bi|$. So, the pixels are not known as edge are zero.

3.8. Edge Detection of License Plate in Gray

Edge detection occurs for an image by transferring image in "gray" and using derivative "sobel". Sobel is able to show strong edges, the edges included license plate are known as strong edges and then the edges will be strengthened and filled the probable holes that led to create an object in image with great area and height than others. Now, the plate should extract as following:

1. Image tagging.
2. Selecting larger object in image.
3. Comparison between an object contains larger area and an object contains larger height.
4. If object is vary with larger area, greatest height will be cut from the end.

Figure 4: Stages of plate edge detection; a: edge detection of image, b: strengthening the edge, c: fill the holes, d: extract the plate from image
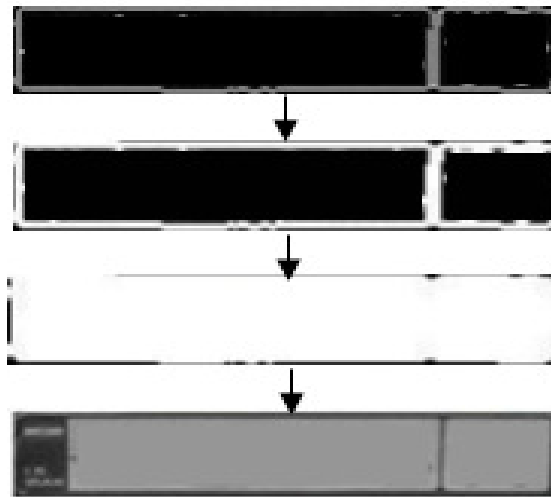
Mentioned algorithms are appropriate to recognize the location and extract the license plate with proper performance in different angles. If another blue object located before the object of license plate as concentration as plate blue, algorithm will be faced to problem. Of course, if there is no exact recognition of colors and disability to recognize the location of license plate, the program prefers to use another algorithm. The related work of this algorithm is mentioned as below:

If blue is visible in a row with different distances, previous related work of algorithm should stop and select second algorithm. In this process, edge detection is used for preprocessing operation for all images and then edges reinforced and probable holes filled as well as numbering images, the object which involved following conditions, will be recognized as license plate:

1. Its height and length respectively are over than 200 and 60 pixels
2. Includes all three colors; black, white and blue. So, it is further possible used as a object for license plate.
3. Includes white points more than black.

3.9. Separating the Characters

After the location of license plate found, separating the characters of license plate will be considered. Although all previous steps have been done perfectly, there is possible for some noises in image of license plate. Image is examined based on the angle of license plate to remain figures of plate characters only. Other figures will be eliminated if they are not in the same line with license plate. In this step, distinguish between figures will be determined by labeling techniques. The labeling and continuity of figures are done through viral replication techniques similar to algorithm of floodfill. Image scanning is done in the same angle of license plate through determining the characters coordinate. Then, the figures in image are counted and if they were less than 8, there is no best qualified for desired candidate to consider as license plate.

3.10. Recognize the Characters

After the license plate extracted, separating the numbers will be studied. A new and unique algorithm is considered for this section. In this regard, first the size of license plate is changed to 200*60 as a specified size to increase the orders performances. It must note that the height of numbers in license plate is smaller than own. It is about 80% and is larger than its half. Also, its width is smaller than greatest object in image. In fact, frame the license plate has more width. So, the frame is not considered. In this regard, edge detection is necessary. Although the edges of numbers are weak, they are essential. Canny is used to extract the edges. But, it is not need to strength the edges, because they should not be stick together. If the numbers stick to frame or any other object in image, it may be visible as similar object and some problems may occur for algorithm. But it is better to strengthen the edges linearly instead of by its width. So, if the numbers were formless by photography in different angles, and incomplete the edge, faulty edges will be completed. By next step, all objects numbered in image and extracted the object based on mentioned conditions. In this regard, small areas such as flag and noises are not known as numbers.

Figure 5: Letters recognition
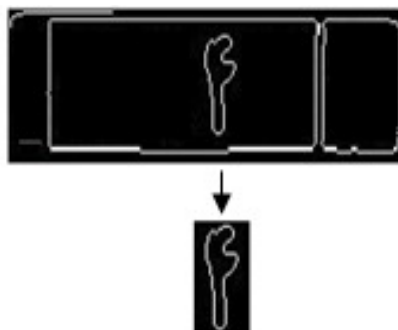
3.11. Compatibility to Pattern

After separating the numbers, now numbers recognition as main part of related work will be considered. It is obvious that the numbers of license plate are determined by a font with a special pattern. Now, it is possible to compare each numbers with own patterns. If one of the patterns is more compatible to image, 86% of patterns are the obtained numbers and desired numbers will be determined. Related work is as following:

The image size of patterns is changed to the size of 50*60 with edge detection. Then, edge detection will be strengthened as well as obtained numbers. Now, all pixels in image are compared column by column. If the values of two pixels were equal, a unit will be added to compatibility variable. The pattern selected as desired number if each patterns have more compatibility variable.

Narrowing the binary zones includes sequential duplication of two following basic steps is in the curve points. Amount of curve point of each pixel is "1" and at least a eight neighbor with the value "0". First step: each point (p) of the curve marked to eliminate if following conditions created in its 8 neighbors:

$2 \leq N(P_1) \leq 6$;

$S_{(P_1)} = 1$;

$P_2, P_4, P_6\text{-}0$;

$P_4, P_6, P_8\text{-}0$;

$N(P_1)$ is the number of non-zero neighbors of P1; i.e,

$N(P_1) - P_2 + P_3 + \ldots + P_8 + p_9$

And $S(P_1)$ is the number of variations "0" to "1" in sequence arranged of $P_2, p_9, P_8 \ldots, p_3 + p_2$.

In second step, conditions (1) and (2) are as first step, but conditions (3) and (4) are changed as following :

$P_2, P_4, P_8\text{-}0$;

$P_2, P_6, P_8\text{-}0$;

Each repetition of the narrowing algorithm consists of the following steps:

1. Implement first step to sign boundary points to remove.
2. Eliminating the signed points.
3. Implementing second step to sign another points to remove.
4. Eliminating the signed points. These processes are done for times as long as another points never removed. So, algorithm will be completed and the structure will be obtained.

Figure 6: Narrowing the image
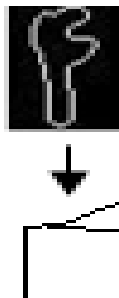
3.12. Post-Processing

Pruning methods are essential for narrowing and structuring algorithms. Narrowing algorithm led to noises in image and should eliminate by post-processing. This is done by pruning technique.

4. Results and Comparison

In this regard, 100 images have been used and included three steps; first step refers to the images with low distance (about 1 to 2 meter) and rotation angle of 0 to 20 degrees. In this reference, 2% of images lost the license plate and just 1% of them have extra points with license plate. Second step include the images with average distance (2 to 4 meter) and rotation angle between 20 to 40 degrees and different lighting (better than first step). Third step include the images with high distance (over than 4 meter) and rotation angle between 0 to 20 degrees. The results are shown in table 1.

Table 1:   The results of searching license plate location of color automobile

	Access to additional points	Lack of access to license plate	Access to license plate
First step Distance between 1 to 2 meter and rotation angle between 0 to 20 degrees and different lighting (day and night)	0.07%	0%	100%
Second step Distance between 2 to 4 meter and rotation angle between 20 to 40 degrees	10%	3%	97%
Third step Distance over than 4 meter and rotation angle between 0 to 20 degrees	30%	0.3%	97%

Using described location, it is possible to recognize several license plates in image very fast. Also, system performance in imaging different situations has been examined and is shown by table 2. Imaging is related to fixed automobiles. The equipment are used for imaging is use of 1.3 mega pixel camera of mobile phone. The distance between camera and automobiles is about 1.5 to 3 meter and include imaging in two positions, direct imaging and without angle, and side-angle imaging. The imaging was done by street projectors and mobile flash.

Table 2:   **E**xamining the system performance in color image with low quality

	Total conditions	correct	Function of recognition (%)
Daylight, direct imaging without angle	250	237	94.8%
Night light, direct imaging without angle	140	128	91.42%
Daylight, side and angled imaging	150	102	68%

4.1. Probability of Errors

Correct performance is not possible for proposed method if there is no high accuracy and clarity or appropriate lighting in picture. Probability errors include as following:
- extract the location larger than license plate
- extract the location smaller than license plate
- extract wrong location as license plate
- lack of extract the special location as license plate

Table 3:   Reviews the error

	Correct extraction of license plate	Extract the location larger than license plate	Extract the location smaller than license plate	Extract wrong location as a license plate	Lack of extract the special location as license plate
NO.	244	24	16	10	6
The recognition	81/3	8	5/3	3/3	2

Table 4: Processing time method

	Proposed method
Essential processing time (ms)	244

5. Conclusion

In this article, special application of machine vision is considered to recognize the number of license plate. Due to rapid advances in sciences such as image processing, neural network, and recognize the optical characters, and also the importance of them for different societies, always proposed innovative methods in this field. An intelligent system for license plate recognition in a automobile needs to some factors such as high speed and accuracy. In order to access these two objectives, some efforts have been done. Also, necessary post-preprocessing used by blue area of license plate in image, it was successful. But, if this process was not successful, another algorithm may use with high probability for conclusion. License plate extracted from image and then the numbers extracted by a new and unique algorithm. Figure compatibility used also to recognize the numbers. In this article, processing tools, image and nature of Iranian license plate are used to present a method for license plate detection in color images and various distances and angles. This method is compatible with different optical status and lighting variations. The results indicate the validity and accuracy of proposed method. Desired method examined on 100 images by different distances (The farthest distance was about 3 meter) with 95% success to recognize the location and separating license plate and numbers. Number recognition was success about 86% for separated numbers. The system performance was good for images with complex background, and angular (less than absolute magnitude, down to about +30), and several license plate. According to study about 100 automobile picture, the accuracy to recognize the location of license plate was 82.44% , accuracy to recognize the numbers was 98.5%, and the accuracy to recognize the letters(alphabets) was 92.4%.

References

[1] X.Shi, W.Zhao, Y.Shen, "Automatic license plate recognition system based on color image processing", In lecture notes on computer science, Vol.3483, O.Gervasi, et al, Eds.New York: Springer-Verlag, pp.1159– 1168, 2005.

[2] W.Jia, H.Zhang, X.He, M.Picccardi, "Mean shift for accurate license plate localization", IEEE/ITS, pp.566-570,2005.

[3] D.Zheng, Y.Zhao, J.Wang, "An efficient method of license plate location", Pattern recognit. Lett., Vol.26, No.15,pp.2431–2438, Nov. 2005.

[4] T.D.Duan, T.L.Hong Du, T.V.Phuoc, N.V.Hoang, "Building an automatic vehicle license plate recognition system",Int. Conf. Comp. Sci. RIVF, pp.59–63, 2005.

[5] J.A.G.Nijhuis, M.H.ter Brugge, K.A.Helmholt, J.P.W.Pluim, L.Spaanenburg, R.S.Venema, M.A.Westenberg, "Car license plate recognition with neural networks and fuzzy logic", IEEE /ICNN, Vol.5, pp.2232-2236, 1995.

[6] Jacek M. Zurada, Introduction to Artificial Neural System,West Publishing Company,10th ed. St.Paul, MN, 2004

[7] Mia Hubert, Peter J Rousseeuw, Karlien Vanden Branden.Technometrics. February 1, 2005, 47(1): 64-79.

[8] Caixia Deng, Yuling Qu And Lijuan Gu, CharacterizationOf Image Space Of A Wavelet Transform, International Journal of Wavelets, Multiresolution and Information Processing Vol. 4, No. 3 (2006) 547–557

[9] G.Hov, J.Zhao,M.Liu, "A license plate recognition method based on tophat-bothat changing and line scanning", Journal of physics, Vol.48, No.1,2006.

[10]   H.C. Wu, C.S.TSAI, C.H.LAI, "A license plate recognition system in e-Government", Information & Security, vol.15, No.2, 2004.

[11]   Draghici Sorin, "A neural network based artificial vision system for license plate recognition", Theses submitted to the Dept. of computer science, Wayne state university.

[12]   A. Broumandnia, M. Fathi, "Application of pattern recognition for Farsi license plate recognition", ICGST Journal, vol. 5, issue2, Jan 2005.

[13]   B.D.Acosta, "Experiments in image segmentation for automatic US license plate recognition", Theses submitted to the Faculty of the Virginia Polytechnic Institute and state University, in Partial fulfillment of the requirements for the degree of Master of Science in Computer Science, Virginia, June 2004.

[14]   R.Parisi, E.D.Claudio, G.Lucarelli, and G.Orlandi, "Car plate recognition by neural networks and image processing", IEEE Inc. Symp. Circuits and Systems, vol.3, 1998.

[15]   I. Maro, M. Chacon, and S. Alejandro Zimmerman, "License Plate Location based on a Dynamic PCNN Scheme", IEEE International Symposium on Computational Intelligence in Robotics and Automation, July 2003.

[16]   D.S.Gao and J.Zhou, "Car License Plates Detection from Complex Scene", International Conference on Signal Processing, Beijing, August 2000.

[17]   G.Adorni, F.Bergenti, S.Cagnoni, "Vehicle license plate recognition by means of cellular automata," in Proc. IEEE Int. Conf. Intelligent Vehicles, 1998.

[18]   Dong-Su Kim and Sung-I. Chien, "Automatic car license plate extraction using modified generalized symmetry transform and image warping", IEEE International Symposium on Industrial Electronics ISIE 2001, Pusan, Korea, Vol.3, June 2001.

[19]   Sung Han Park, Kwang In Kim, Keechul Jung, and Hyung Jin Kim, "Locating Car License Plates Using Neural Network", IEEE, Vol.35, no.17, Aug 1999.

[20]   M.Soryani, and N.Rafat, "Application of genetic algorithms to feature subset selection in a farsi OCR", International journal of applided science, engineerinf and technology, Vol.3, No.2, 2006.

[21]   C.Lei He, P.Zhang, J.Dong, C.Y.Suen, T.D.Bui, "The Role of Size Normalization on the Recognition Rate of Handwritten Numerals", Centre for Pattern Recognition and Machine Intelligence, Concordia University, Montreal, 2006.

[22]   A.M.Sarhan, O.I.AlHelalat, "Arabic character recognition using artificial neural network and statistical analysis", World Academy of Science, Engineering And Technology, Vol.21, MAY 2007.

[23]   Ben Amor Nadia, Ben Amara Najoua Essooukri, "Moltifont Arabic Character Recognition Using Hough Transform and HMM/ANN Classfication", Journal of Multimedia, Vol.1, No.2, MAY 2006.

[24]   M.D.Garris, J.L.Blue, G.T.Candela, D.L.Dimmick, J.Geist, P.J. Grother, S.A.Janet, C.L.Wilson, "Offline Handwriting Recognition from Forms", IEEE Int. Conf. on Systems Man & Cyb, Vol.3, Oct 1995.

[25]   R.Ghosh, M.Ghosh, "An intelligent offline handwriting recognition system using evolutionary neural learning algorithm and rule based over segmented data points", Journal of research and practice in information technology, Vol.37, No.1, Feb 2005.

A State of Art Review of Dispersive Soils: Identification Methods Perspective

Hassan Shoghi
Department of Civil Engineering, Science & Research Branch
Islamic Azad University (IAU), Tehran, Iran

Mahmoud Ghazavi
Associate Professor, Civil Engineering Department
K.N. Toosi University of Technology, Tehran, Iran

Sina Kazemian
Corresponding Author, Department of Civil Engineering
Bojnourd Branch, Islamic Azad University, Bojnourd, Iran
E-mail: Sina.Kazemian@gmail.com

Hossein Moayedi
Faculty of Engineering
Kermanshah University of Technology, Kermanshah, Iran

Abstract

Dispersive soils are characterized by an unstable structure (disperse and crumb easily and rapidly) without significant mechanical assistance in water of low-salt concentration. These soils are highly erodible in nature and tend to erode under low flow rate. Using dispersive soils in different structures like dams, embankment and roadway may cause serious engineering problems which are worldwide, and several structure failures have occurred and reported in many countries. Soil dispersion is a physical–chemical phenomenon that is caused due to presence of certain approach each other. However, in many countries, this material covers a substantial land area and identification of these soils is necessary for geotechnical engineers. In this paper, the dispersive soils and their mechanism are described from chemistry view point, furthermore the dispersive soil identification methods are discussed in the perspective of qualitative methods evaluations; the advantages and disadvantages of these methods are discussed as well.

Keywords: Dispersive soil, Internal erosion, Emerson class number, Double hydrometer test, Pinhole test, Crumb test, Chemical method, Free swell test .

Introduction

Dispersive soils are characterized by an unstable structure, easily flocculated in water, and very erodible (McCook et. al. 1991, Zorlueret al., 2010). Soil dispersion is a phenomenon in which soil particles become afloat when they are exposed to water, and are carried away by the force of seepage (Volk, 1937; Aitchison et al., 1963, Mitchell, 1993; Abbasi and Nazifi, 2012). These soils are highly erodible in nature and tend to crumble in the presence of water and erode under low flow rate, which

leads to stability problems in earthworks. Erosion due to soil dispersion depends on the mineralogy and chemical composition of clay as well as on the salts dissolved in interstitial water.

Soil dispersivity is mainly due to the presence of exchangeable sodium present in the composition of clays, in which the attractive forces are weaker than the repulsive ones. This enables the particle to separate and move freely. The phenomenon of erosion occurs when fluid flow-induced shearing stresses on a surface reach values great enough to cause particle removal from the surface. In erodibility criteria for noncohesive soils, the main resistance to erosion is provided by the submerged weight of the sediment, i.e. gravity forces. The mechanism of cohesive soil erosion is basically a complex phenomenon involving the structure of the soil and the nature of the interaction between the pore and eroding fluids at the surface (Arulanandan and Heinzen, 1977; Bell, 1994).

Dispersive soils are one of the most common problematic soils in several countries around the world which can cause severe damages to hydraulic structures such as earth dams and irrigation structures (Stapledon et al., 2005; Bhuvaneshwari et al., 2007). Aitchison and Wood (1965) emphasized that the presence of dispersive soils either in the soil used to construct a dam, or in the dam foundation, greatly increases the risk of failure of the dam by "piping failure", i.e. development of erosion to the extent that a hole develops through the embankment, with rapid loss of water from the storage. In earth dams and embankments in contact with water, piping will start by concentration of flow towards the cracks on the downstream side of the structure which progresses to the upstream side in the form of a pipe until it reaches the water source, at which time a rapid catastrophic failure may result (Knodel 1991). In concrete lined canals, destruction begins with formation of cracks, rupture and displacement of lining in the final stages (Rahimi and Abbasi, 2008).

As it stated above, identification of dispersive soil is crucial issue, these soils can be identified in two separated methods: a) Quantitative evaluation methods, and b) Qualitative evaluation methods. Quantitative methods are out of scope here and the reader should be referred to Heinzen (1976) and Arulanandan et al, (1975a).

Erosion/dispersion is depended to several items like: amount and type of clay, pH, organic matter, temperature, water content, thixotropy and type and concentration of ions in the pore and eroding fluids, swelling potential, and slaking. The test methods present a direct, qualitative measurement of the dispersibility and consequent colloidal erodibility of clay soils are: i) Double Hydrometer Test, ii) Crumb Test, iii) Pinhole Test, and iv) Chemical Test.

Double Hydrometer Test

Double Hydrometer test is the most commonly used laboratory method for determining the dispersion potential of soils; it also known as the soil conservation service (SCS) test or percent dispersion test (Standards Australia, 1997; ASTM 2001). In Double Hydrometer test, gradation curve of the soil is drawn in two cases; using standard hydrometer test and hydrometer test without employing dispersing agent and mechanical mixer. The percentage of particles smaller than 0.005 mm in both methods is then determined and **dispersion ratio** is calculated as the ratio of the percentage of particles smaller than 5 micron in the method without using dispersing agent and mixer to the percentage of particles smaller than 5 micron in the standard method. If the dispersion ratio is more than 50%, the soil has dispersion potential, and if the result is between 30 and 50%, it shows intermediate dispersion potential and <30 % shows non-dispersive nature of the soil (Asgari and Fakher (1994); Knodel, (1991)). Decker recommended that this limit is about %40 in the inorganic clay and it is considered about % (25 to 30) in the low plastic mud, clayey and muddy sand.

Ryker (1977) stated that, this method is applicable only to soils with a plasticity index greater than 4 as determined in accordance with Test Method D 4318 and more than 12 % of the soil fraction finer than 5-µm as determined in accordance with Test Method D 422. In addition of that, the single-operator co-efficient of variation has been found to be 3.9%. Therefore, results of two properly conducted tests by the same operator with the same equipment should not be considered suspect unless they differ by more than 11.1 % of their mean (ASTM, 1999).

Crumb Test

Crumb test is a simple and quick method for identification of a dispersive clay soil in field or laboratory. It was originally developed by Emerson (1964), was called the aggregate coherence test and had seven different categories of soil-water reactions. Sherard (1976a,b) later simplified the test by combining some soil-water reactions so that only four categories, or grades, of soil dispersion are observed during the test. In this method, dispersive clay soils are identified by observing the behavior of a few crumbs (approximately two to three soil crumbs, each about 6mm to 10mm diameter) which prepare from representative portions of the soil at the natural moisture content of soil place on the bottom of a white porcelain dish containing 250 mL of distilled water. The reaction of the soil crumbs will be observed for 5 to 10 minutes (ASTM D6572, 2000).

Test specimens in crumb test is divided by ASTM D6572 (2000) to two different types based on their preparations: i) from natural, irregularly shaped soil crumbs (Test Method A, Natural Soil Crumbs), and ii) be remolded from material passing a 2-mm (No. 10) sieve (Test Method B, Remolded Specimens).

BS 1377 (1990) emphasized that, distilled water provides as good an indicator as the sodium hydroxide solution but, many dispersive clays do not show a dispersive reaction in distilled water even though they do in the solution so its recommended 0.001M dilute solution of sodium hydroxide sodium hydroxide is better than distil water.

Observations of the behavior of the crumbs in accordance with the following guidelines are mentioned by ASTM (2002):

- Grade 1: No reaction. Crumbs may slake or run out to form a shallow heap on the bottom of the beaker, but there is no sign of cloudiness caused by colloids in suspension.
- Grade 2: Slight reaction. A very slight cloudiness can be seen in the water at the surface of a crumb.
- Grade 3: Moderate reaction. There is an easily recognizable cloud of colloids in suspension, usually spreading out in thin streaks at the bottom of the beaker.
- Grade 4: Strong reaction. A colloidal cloud covers most of the bottom of the beaker, usually as a thin skin. In extreme cases all the water becomes cloudy.

Grades 1 and 2 represent a non-dispersive reaction, and grades 3 and 4 a dispersive reaction (BS 1377, 1990).

Pinhole Test

Pinhole dispersion classification, also known as the pinhole test, or Sherard pinhole test; this test was developed by Sherard et al. (1976b). In this test, distilled water is caused to flow through a 1 mm diameter hole formed in a specimen of re-compacted clay under a controlled hydraulic head. The resistance to erosion of the clay is judged visually by the presence or absence of turbidity in the water which emerges and from measurements of rates of flow and the final hole diameter. Table 2 shows the classification of dispersion soils in pinhole test method, which is classified to dispersive soil (category D1 or D2) or non-dispersive soil (categories ND1 to ND4). The results from the test at 50 mm head of water shall be used as the principal means of differentiating dispersive from non-dispersive soils as defined by this test. If the water is not substantially clear and the rate of flow has increased to between 1.0 and 1.4 mL/s the test is complete (BS 1377, 1990).

Flow from dispersive clays will be distinctly dark and the hole through the specimen will enlarge rapidly, with a resultant increase in the flow rate. Flow from slightly to moderately dispersive clays will be slightly dark with a constant hole size and flow rate. Flow from non-dispersive clays will be completely clear with no measurable increase in the hole size. Three alternative procedures for classifying the dispersibility of clay soils are provided as follows (ASTM D4647, 2006):

- **Method A:** D1, D2—Dispersive clays that fail rapidly under 50 mm (2 in.) head. ND4, ND3—Slightly to moderately dispersive clays that erode slowly under 50 mm (2 in.) or 180 mm (7 in.) head. ND2, ND1—Nondispersive clay with very slight to no colloidal erosion under 380-mm (15 in.) or 1020 mm (40 in.) head.

- **Method B:** D—Dispersive clays that erode rapidly under 50 mm (2 in.) head. SD—Slightly dispersive clays that erode slowly under 180 mm (7 in.) head. ND—Nondispersive clays that show very slight or no colloidal erosion under 380 mm (15 in.) head.
- **Method C:** D1, D2—Dispersive clays that fail rapidly under 50 mm (2 in.) head. ND4, ND3—Dispersive clays that erode slowly under 50 mm (2 in.), 180 mm (7 in.), or 380 mm (15 in.) head. ND2, ND1—Nondispersive clay with very slight to no colloidal erosion under 380 mm (15 in.) head.

Its mentioned that (ASTM D4647, 2006), Method A and Method C of the pinhole test require the evaluation of cloudiness of effluent, final size of the pinhole, and computation of flow rates through the pinhole in order to classify the dispersive characteristics of the soil. Method B requires only the evaluation of the cloudiness of effluent and final size of the pinhole to classify the dispersive characteristics of the soil. The computation of flow rates through the pinhole in Method A serves primarily as a guide to the proper equipment and specimen performance under sequential pressures applied during the test (in evaluating test results from undisturbed samples, the cloudiness of the effluent emerging from the specimen may be more important than the rate of flow, it is also important that characteristics of the hole at the end of the test be carefully observed and recorded). Method B for classifying dispersiveness of clay soils combines the categories of Method A as follows: D=D1, D2, ND4; SD= ND3; and ND= ND2, ND1. All methods produce similar results and any method can be used to identify dispersive clays, the details of mentioned methods are shown in Tables 1, 2 and Figure 3.

Table 1: Criteria for Evaluating Pinhole Test Results-Method A (ASTM D4647, 2006)

Dispersive classification	Head, mm	Test time For given head, min	Final flow rate Through specimen, mL/s	Cloudiess of flow at end test		Hole size after test, mm
				From side	From top	
D1	50	5	1.0-1.4	Dark	Very dark	**≥2.0**
D2	50	10	1.0-1.4	Moderately dark	Dark	**≥1.5**
ND4	50	10	0.8-1.0	Slightly dark	Moderately dark	**≥1.5**
ND3	180	5	1.4-2.7	Barely visible	Slightly dark	**≥1.5**
	380	5	1.8-3.2			
ND2	1020	5	>3.0	clear	barely	**≥1.5**
ND1	1020	5	≤3.0	Perfectly clear	Perfectly clear	**<1.5**

Table 2: Criteria for Evaluating Pinhole Test Results-Method B (after, ASTM D4647, 2006)

D	**50**	**10**	**. . .**	**Slightiy dark to dark**	**Very dark to moderately dark**	**≥1.5**
SD	180-380	5	. . .	Barely visible	Slightiy dark	**≥1.5**
ND	380	5	. . .	clear	Barely visible to clear	**<1.5**

Figure 3: Criteria for Evaluating Pinhole Test Results-Method C (after, ASTM D4647, 2006)

TEST TIME (MINUTES)
DISPERSIVE GRADE VS   FLOW RATE
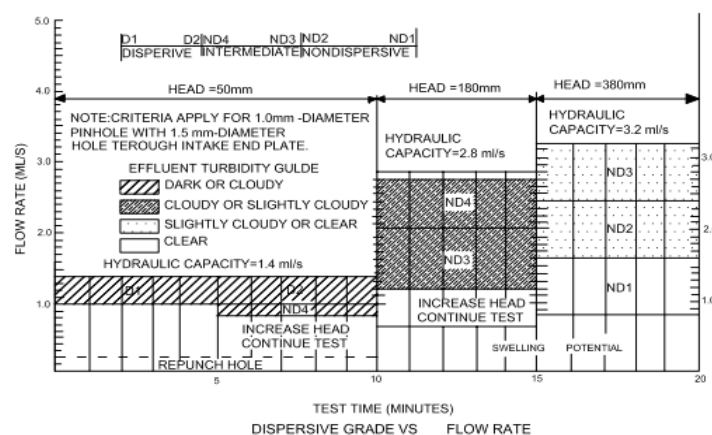
Sherard et al. (1976a) indicate that soils with a percent dispersion greater than 50% are susceptible to dispersion and piping failure in dams, and those with a percent dispersion less than 15% are not susceptible. A percent dispersion of less than 30% is unlikely to test dispersive in the pinhole test. Bell and Maud (1994) indicate that soils with >50% dispersion are regarded as highly dispersive, 30–50% moderately dispersive, 30% to 15% slightly dispersive, and <15%, non-dispersive.

Chemical Test

Although a number of methods have been suggested for identification of dispersive soils, careless tests and/or inappropriate interpretation of their results may lead to incorrect assessment of the problem. One of the most commonly used laboratory methods for determining the dispersion potential of soils is Sherard chemical method. It has been elaborated that the nature of clay dispersion phenomenon is chemical and that tendency to erosion depends on chemical properties of dissolved salts in pore water, accurate and proper interpretation of the chemical tests results would lead to reliable assessment of soil dispersivity (Ingles and Aitchison 1969; Sherard et al. 1976).

This method is based on correlation with many dam failures and soil from dams which have leaked continuously (without any filters to control erosion) and not failed (Sherard et al., 1976a). According to Sherard chemical method, the dispersion potential of the soil is evaluated with respect to the type and quantity of cations present in pore water of the soil sample. For this purpose, saturation extract is prepared from the soil sample, then its four main cations namely; calcium, magnesium, sodium, and potassium are determined in terms of milliequivalents per liter and the amount of total dissolved salts (TDS) and the percentage of sodium (PS) (equations 1 and 2) are calculated. The dispersion potential of the soil sample is evaluated from the Sherard diagram as shown in Figure 4. The diagram is divided into three zones: Dispersive (zone A), Non-dispersive (zone B), and the Intermediate (zone C) based on Percent Sodium (PS) and Total Dissolved Salt (TDS) of the soil extract (Knodel 1991).

$$Percent\ Sodium\ (PS) = \frac{Na^+}{Total\ Dissolved\ Salts} \times 100 = \frac{Na^+}{Ca^{2+} + Mg^{2+} + Na^+ + K^+} \times 100 \qquad \text{Eq. (1)}$$

$$Sodium\ Absorption\ Ratio\ (SAR) = \frac{Na^+}{[0.5 \times (Ca^{2+} + Mg^{2+})^{0.5}]} \qquad \text{Eq. (2)}$$

Figure 4: Determination of dispersive soil in Chemical test
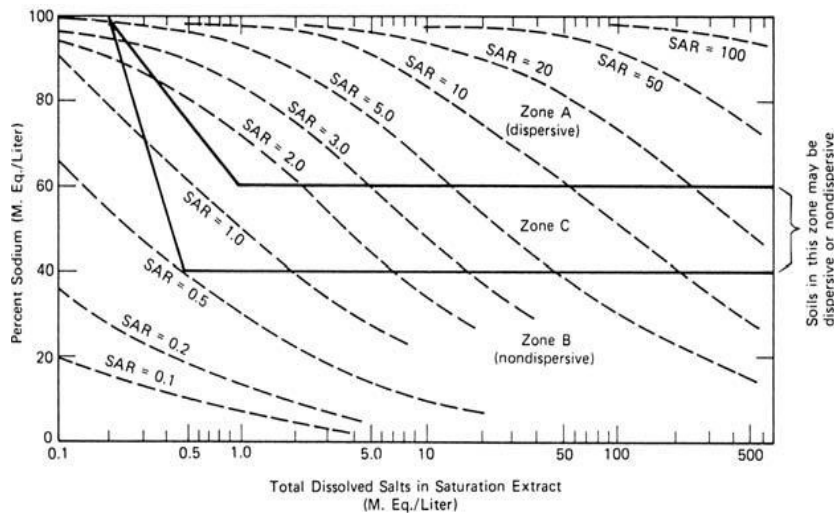
Conclusions

Dispersive soils are one of the most common problematic soils in several countries around the world which can cause severe damages to hydraulic structures. Erosion/dispersion is depended to several items like: amount and type of clay, pH, organic matter, temperature, water content, thixotropy and type and concentration of ions in the pore and eroding fluids, swelling potential, and slaking. Double Hydrometer Test, Crumb Test, Pinhole Test, and Chemical Test, are the most common used test methods which present a direct, qualitative measurement of the dispersibility. Since all mentioned test methods may not identify all dispersive clays, design decisions based solely on one test method may not be conservative. It is often run in conjunction with or combination of at least three or four methods, to identify possible dispersive clay behavior.

References

[1]   Aitchison, G. D., Ingles, O. G., and Wood, C. C. (1963), "Post-construction Deflocculation as a Contributory Factor in the Failure of Earth Dams," Proceedings of 4th Australia-New Zealand Conf. on Soil Mech. And Found. Engg., 275-279.

[2]   Abbasi N. & Nazifi M. H. (2012) "Assessment and Modification of Sherard Chemical Method for Evaluation of Dispersion Potential of Soils", Geotechnical and Geological Engineering, DOI 10.1007/s10706-012-9573-7.

[3]   Aitchison, G. D., and C. C. Wood, (1965) "Some Interactions of Compaction, Penneability, and Post-Construction Deflocculation Affecting the Probability of Piping Failures in Small Dams," Proceedings, 6th International Conference on Soil Mechanics and Foundation Engineering, Montreal, Canada, International Society of Soil Mechanics and Foundation Engineering, vol. II, p. 442.

[4]   Arulanandan K. & Heinzen R. T., (1977), "Factors Influencing Erosion in Dispersive Clays and Methods of Identification", IAHS Publication (122): 75-81

[5]   Arulanandan, K., Loganathan, P. and Krone, R. B. (1975a) "Pore and Eroding Fluid Influences on the Surface Erosion of a Soil", Geotech. Engng Div., Proc. Amer. Soc. Civ. Engrs, 53-66.

[6]   ASTM Standard D4221-99, (1999) "Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer", ASTM International, West Conshohocken, PA, www.astm.org.

[7]   ASTM Standard D4647-06, (2006), "Standard Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole test", ASTM International, West Conshohocken, PA. www.astm.org.

[8]   ASTM Standard D6572-00, (2000), "Standard Test Methods for Determining Dispersive Characteristics of Clayey Soils by the Crumb Test", ASTM International, West Conshohocken, PA. www.astm.org.

[9]   Asgari, F.A. & Fakher A. (1994), "Soil Swelling and Dispersion from a Geotechnical Engineers Point of View", Jihad Daneshgahi Publications, Tehran University, pp: 245.

[10]   Arulanandan, K., Krone, R.B. & Loganathan, P., (1975), "Pore and Eroding Fluid Influences on the Surface Erosion of a Soil," J. Geotech. Eng. Div., ASCE, Vol 100, No. GT-6, pp. 51–66.

[11]   British Standards BS 1377, (1990) "Soil for Civil Engineering Purposes", Part 5.

[12]   Bell FG, Maud RR (1994) "Dispersive Soils: A Review From a South African Perspective", Quarterly Journal of Engineering Geology 27, 195-210.

[13]   Bhuvaneshwari S, Soundra B, Robinson RG, Gandhi SR (2007) "Stabilization and Microstructural Modification of Dispersive Clayey Soils", First International Conference on Soil and Rock Engineering Organized by Srilankan Geotechnical Society, Columbo, Srilanka, 5–11 August 2007.

[14]   Emerson, W.W., (1964), "A Classification of Soil Aggregates Based on Their Coherence in Water," Australian Journal of Soil Research, Vol 2, pp. 211-217.

[15]   Heinzen, R. T. (1976), "Erodibility Criteria for Soils", MSc Thesis, University of California, Davis, California.

[16]   Ingles OG, and Aitchison GD (1969) "Soil-Water Disequilibrium as a Cause of Subsidence in Natural Soils and Earth Embankments", In: Symposium on Land Subsidence, Tokyo, AIHS Publication no 89, vol 2.

[17]   Knodel PC (1991) "Characteristica and Problems of Dispersive Clay Soils", US Department of the Interior, Bureau of Reclamation, Denver, Office, R-91-09

[18]   McCook, D. and McElroy, C. (1991). "Dispersive Clays," Soil Mechanics Note No.13. U.S. Department of Agriculture Soil Conservation Service, Engineering Division.

[19]   Mitchell, J. K. (1993), "Fundamentals of Soil Behavior", 2nd Ed., Wiley, New York.

[20]   Rahimi H, Abbasi N (2008) "Failure of Concrete Canal Lining on Fine Sandy Soils (A Case Study for Saveh Project)" J Irrig Drainage 57:83–92.

[21]   Ryker, N. L., (1977), "Encountering Dispersive Clays on Soil Conservation Service Projects in Oklahoma," Dispersive Clays, Related Piping, and Erosion in Geotechnical Projects, ASTM STP 623, pp. 370–389.

[22]   Sherard JL, Dunnigan LP, Decker RS (1976a) "Identification and Nature of Dispersive Soils", Journal Geotechnical Division, proceedings ASCE 102, 287-301.

[23]   Sherard, 1. L., L. P. Dunnigan, and R. S. Decker, (1976b) "Identification and Nature of Dispersive Soils," Journal, Geotechnical Division, ASCE, vol. 102, No. GT4, April.

[24]   Sherard, L., Dunnigan, L. P. and Talbot, R., (1984b) "Filters for Silts and Clays," Journal, Geotechnical Engineering Division, ASCE, vol. 110, No.6, June.

[25]   Sherard JL, Dunnigan L. P., and Decker RS, (1977) "Some Engineering Problems with Dispersive Clays ASTM STP 623", American Society for Testing Materials, 3-12.

[26]   Sherard, L., and Decker, R. S.(1977), "Dispersive Clays, Related Piping, and Erosion in Geotechnical Projects," STP 623, ASTM, Philadelphia, PA.

[27]   Sherard, J. L., Decker, R. S., and Ryker, N. L., (1972) "Piping in Earth Dams of Dispersive Clay," Proceedings of the Speciality Conference on Performance of Earth Supported Structures, American Society of Civil Engineers.

[28]   Stapledon D. , MacGregor P. , Bell G. and Fell R., (2005) "Geotechnical Engineering of Dams", Taylor & Francis Press, Pp: 292-316.

[29]   Volk, G. M., (1937), "Method of Determination of Degree of Dispersion of the Clay Fraction of Soils," Proceedings, Soil Science Society of America, Vol II, p. 561.

[30]   Zorluer I., Icaga Y., Yurtcu S. & Tosun H., (2010), "Application of a fuzzy rule-based method for the determination of clay dispersibility" ,Geoderma Journal 160, Pp 189–196.

Predictors of Hepatitis B Vaccine Acceptance among Nigerian Primary Health Care Workers

Abdulraheem IS
Department of Epidemiology & Community Health
College of Medicine, University of Ilorin, Nigeria

Tobin-West CI
Department of Preventive & Social Medicine, College of Health Sciences
University of Port-Harcourt, Nigeria

Amodu MO
Department of Community Medicine
College of Medical Sciences, University of Maiduguri, Nigeria

Salami SK
Department of Community Medicine, College of Health Sciences
Ladoke Akintola University of Technology, Osogbo, Nigeria

Abstract

Background: Hepatitis B (HB) is a serious and common infectious disease of the liver. The World Health Organization (WHO) in 2009 reported HB to infect nearly 2 billion people around the world. The potential for Hepatitis B Virus (HBV) transmission in the occupational setting is greater than for human immunodeficiency virus (HIV). The center for disease control (CDC) estimates that 18,000 healthcare workers whose jobs involve exposure to blood became infected with HBV each year. As a result, 250 people will die of fulminate hepatitis, cirrhosis, or liver cancer

Objective: This study assesses the prevalence, predictors, relative importance of occupational, epidemiologic, and attitudinal factors in hepatitis B vaccine acceptance.

Method: Stratified random samples of 950 health care workers at risk of occupational blood exposure in primary health care centers were studied. Potential reasons for vaccine acceptance or refusal were evaluated with factor analysis. Logistic regression analysis was used to identify independent predictors of initiating and completing the vaccination.

Results: The prevalence of acceptance of HBV vaccination was 79.4%, and of these, 22.5% had completed the required HBV vaccination doses while 48 % had not been vaccinated at all. About two-third (65.4%) of the unvaccinated subjects said they would accept vaccination if offered. Hepatitis B vaccine acceptance was related strongly to history of accidental exposure to blood or blood products, social & peer influence (physicians, supervisors, role models, friends, and spouse) and knowledge of the disease and vaccine, whereas refusal was primarily related to concern about vaccine side effects and problems with vaccine access.

Conclusion: Hepatitis B vaccine should be offered routinely to health care workers with increased risk of exposure to blood and blood products as well as during evaluation

for occupational blood exposure. Health workers must also be educated on occupational disease risk, liability, and the safety of the hepatitis B vaccine.

Keywords: Hepatitis B, Acceptance, Predictors, Health worker, Nigeria

Introduction

Hepatitis B is an important, infectious, occupational hazard for healthcare workers exposed to human blood or blood borne products (1-3). HBV is 50 to 100 times more infectious than HIV, and it is an important cause of liver diseases such that chronic infection with HBV is a common cause of death associated with liver failure, cirrhosis, and liver cancer (4-6). The endemicity of HBV in Nigeria has been variously described [7-9]. HBV is a serious and common infectious disease of the liver. The World Health Organization (WHO) in 2009 reported HB to infect nearly 2 billion people around the globe. Furthermore, out of these 2 billion, 350 million suffered from chronic, lifelong infection (10)].

Even though hepatitis B vaccination is highly effective in preventing infection with HBV and consequent acute and chronic liver disease [1], this infection is still a major problem in Nigeria as reported by various studies [9,11,12]. There is a need for studying the trend of infection in the general population especially among the health workers as a necessary tool for effective intervention initiatives cannot be overemphasized. Heath workers infected victims not only suffer considerable harm, but may sometimes also inadvertently transmit the infection to patients they care for.

Regions of the world that have a prevalence of 8% or more are classified as highly endemic areas (13), and Nigeria happens to be in this group. HBV infection occurs frequently in Nigeria [14, 15]. It is estimated that about 12% of the total Nigerian population of 140 million is chronically infected with Hepatitis B virus [16, 17]. The global prevalence of chronic hepatitis B infection varies widely, from >8% in Africa, Asia, and the Western Pacific to 2–7% in Southern and Eastern Europe, and to <2% in Western Europe, North America, and Australia. In the United States of America, an estimated 185,000 new infections evolved yearly [18.].

Despite the existence of a safe and effective vaccine, Nigeria has remained a hyper-endemic area for hepatitis B virus infection, with an estimated 12% of the total population being chronic carriers [19]. Hepatitis B virus infection continues to be a substantial and devastating health problem, with new cases still being reported annually [20, 21]. Even though Nigeria approved the inclusion of hepatitis B vaccine in its National Program on Immunization (NPI) in 1995, the vaccine only became widely available in 2004 [22]. Despite the fact that the vaccine had been made available via the NPI, immunization, coverage for Hepatitis B is still not optimal in low resource settings in Nigeria [22].

A study in Nigeria showed that the Hepatitis B vaccine coverage rate in low resource settings is currently about 41% [23]. The consequences of the problems of low pick up rate of HBV infection due to poor screening and the low vaccination rate are that vertical transmission of hepatitis B virus has become the major route of transmission of the virus in Nigeria. This has a major impact on the babies when born because of the risk to developing chronic liver diseases later in life. The objective of this study was to assess the prevalence, relative importance of occupational, epidemiologic, and attitudinal factors in hepatitis B vaccine acceptance among Nigerian Primary Health Care Workers.

Purpose of the study: The purpose of this study is to determine the effects of perceived threat and knowledge level about Hepatitis B virus on the motivation to accept hepatitis B vaccine among healthcare workers.

Research problem: What is the relationship between perceived threat and knowledge level and the acceptance of hepatitis B vaccine among healthcare workers?

Research Hypothesis: (a) *Null Hypothesis.* There is no association between perceived threat and knowledge level and the acceptance of hepatitis B vaccine among healthcare workers. **(b)** *Alternative* (**Statistical**) **Hypothesis.** The perceived threat and knowledge level is associated with increased acceptance of hepatitis B vaccine among healthcare workers

Definition of Terms

1. Knowledge of hepatitis B infection refers to health workers having correct information/knowledge about mode of transmission of HBV, incubation period, high-risk groups, signs and symptoms, and vaccination doses.
2. Acceptance of HBV vaccination refers to health workers with a history of receiving at least one or more doses of hepatitis B vaccine.
3. Complete vaccination refers to health workers who had had three doses of vaccine
4. Partial vaccination refers to workers who had less than 3 doses of hepatitis B vaccine.

Theoretical Frame work: The Health Belief Model (HBM) was formulated in the early 1950's by a group of social psychologist at the U.S. Public Health Service in an effort to provide a framework for analyzing why some people who are illness free take actions to avoid illness, while others fail to take such protective actions (Rosenstock, 1988, p. 175).

Although the model evolved gradually in response to very practical programmatic concerns, its basis in psychological theory and provided as an aid to understanding its rationale as well as its strengths and weaknesses (Carmel, 1990, p 74). Many investigations have helped expand and clarify the Health Belief Model and extended it beyond screening behaviors to include all preventive actions, illness behaviors and sick-role behavior.

In general, it is believed that individuals will take action to ward off, to screen for, or to control ill-health condition if they regard themselves as susceptible to the condition, if they believe it to have potentially serious consequences, if they believe that a course of action available to them would be beneficial in reducing either their susceptibility to or the severity of the condition, and if they believe that the anticipated barriers taking the action are outweighed by its benefits (Glans, 1990, p. 220).

It is an appropriate model for this study of motivation to accept HB vaccine, as it was designed to explain or predict health protecting or preventive behavior. It has been applied mainly in situations where the behavior in question in purely voluntary and the individuals studied do not believe themselves to have dysfunctional systems. The authors of the model suggest that health care providers need to learn that; behavior is motivated, certain beliefs seem central to a client's decision to act; not all persons poses these beliefs and motives to equal degrees; and intellectual information, while necessary, is often not sufficient to stimulate needed beliefs (Becker, 1974, p.21; Glans, 1990, p. 215).

Variables of Health Belief Model

1. **Perceived Susceptibility.** The dimension of perceived susceptibility refers to one's subjective perception of the risk of contracting a health condition. In the case of medically established illness, the dimension has been reformulated to include acceptance of the diagnosis, personal estimates of re-susceptibility and susceptibility to illness in general.
2. **Perceived Severity.** Feelings concerning the seriousness of contracting an illness or of leaving it untreated include evaluations of both medical and clinical consequences (example: death, disability and pain) and possible social consequences (such as effects of the conditions on work, family life and social relations). Many investigators have found it useful to label the combination of susceptibility and severity as a perceived threat (Carmel, 1990, p. 75).
3. **Perceived Benefits.** While acceptance of personal susceptibility to a condition also believed to be serious (perceived threat) it is held to produce a force leading to behavior, it does not define the particular course of action that is likely to be taken. This is hypothesized to depend upon beliefs regarding the effectiveness of the various available actions in reducing the disease threat, or the perceived benefits of taking health action. Thus, an individual exhibiting an optimal level of beliefs in susceptibility and severity would not be expected to accept any recommended health action unless that action was perceived as feasible and efficacious.
4. **Perceived Barriers.** The potential negative aspects of a particular health action, or perceived barriers, may act as impediments to undertaking the recommended behavior. A kind of unconscious, cost-benefit analysis is thought to occur wherein the individual weighs an

action's effectiveness against perceptions that is may be expensive, dangerous (having negative side effects or intragenic outcomes), unpleasant (painful, difficult, upsetting), inconvenient, time-consuming and so forth. Thus, the combined levels of susceptibility and severity provided the energy or force the act and the perception of benefits "less barriers" provided a preferred path of action (Glans, 1990, p .217).

5. **Readiness to Engage in Health Behavior.** The outcome of a person's perceived susceptibility to a serious health threat and a person's perceived benefits of taking action to reduce the threat.

6. **Other Variables.** It is believed that diverse demographic, sociopsychological, and structural variables may, in any given instance, affect the individual's perception and thus indirectly influence health related behavior. Specifically, sociodemographic factors, particularly educational attainment, are believed to have an indirect effect on behavior by influencing the perception of susceptibility, severity, benefits and barriers.

METHODOLOGY: *This is a descriptive cross-sectional study conducted among Stratified random samples of 950 health care workers at risk of occupational blood exposure in primary health care centers in Nigeria. The study was conducted between October2011 and March 2012.*

Data were collected using a self administered survey questionnaire. This study was designed with the goal of finding the sample's knowledge base, acceptance responses, and the relationship between knowledge and acceptance of hepatitis B vaccine among health care workers. The questionnaire contains 36 multiple choice and open ended questions that measures the extent of knowledge, perceived susceptibility, perceived severity, and also perceived barriers and acceptance of hepatitis B vaccine of those health care workers regarding hepatitis B vaccine.

The inclusion criteria were PHC workers who were involved in clinical practice and with increase risk of exposure to blood or blood products and a consent (written or verbal) to participate in the study was given before collecting data. PHC workers who had a history of HBV infection in the previous 12 months were excluded.

The content validity of the questionnaire was reviewed by Epidemiologist expert before it was pretested in a sample of 45 health workers outside the study areas. The pretest was to assure the reliability of the questionnaire and remove ambiguity. Nine hundred and fourteen health workers completed the questionnaire, thus giving a response rate of 96.2%.

During the study period, there was no Ethical Review Committee in the study areas; only written and verbal consent to conduct the study was obtained from the health care workers.

Subjects who consented to participate were approached for face-to-face interviews lasting approximately 40 minutes. Information obtained included age, sex, job description, years of employment, highest grade completed in school, knowledge of hepatitis B, desire to be vaccinated, perception of likelihood of subject contracting hepatitis B, and the perception of severity of HBV infection.

Using descriptive statistics, the data was analyzed in terms of frequency distribution, percentage and cross tabulation using EPI-info soft ware package version 6.0. Chi-square significance testing and cross tabulations were used to describe the relationship between the variables of acceptance of hepatitis B vaccine and knowledge, perceived threat or perceived barriers

Potential reasons for vaccine acceptance or refusal were evaluated with factor analysis. Logistic regression analysis was used to identify independent predictors of initiating and completing the vaccination. Associations were expressed as odds ratios (ORs) and 95% confidence interval (CI). All variables with a p value of ≤0.05 were expressed as statistically significant.

Result

Nine hundred and fourteen health workers completed the questionnaire, thus giving a response rate of 96.2%. The age range of respondents were from 24 to 45 years (mean±SD=28±2.3 years). of all the participants, 40.2% had nursing training while 30.8 had midwifery training and 29% were community health assistants. More than three-quarter (89.3%) had been exposed to patient blood or other bodily

fluids on the job during the previous three months. More than one-fifth (20.7%) had been exposed to needle-stick injuries once while 30.3% had needle stick injury twice and 43.5% had needle stick injury two times and more while 5.5% had never had any needle stick injury.

Of the 89.3% who reported accidental exposure to blood or other bodily fluids, 72.6% stated that it occurred while giving an injection and 16.7% stated that it occurred while giving an intravenous infusion. (Table1).

Table 1:   Characteristic of respondents

Variables	Frequency	Percentage
Gender		
Male	330	34.7
Female	620	65.3
Age		
24-29	105	10.1
30-34	580	61.1
35-39	205	21.6
40-44	60	6.2
Marital Status		
Married	706	74.3
Single	180	20.0
Divorce	28	3.0
Separated	36	3.7
Professional Qualification		
Nurse	382	40.2
Midwife	293	30.8
Community Health Assistant	275	29.0
Years of experience		
Less than 5	70	7.3
5-9	100	10.5
10-14	160	16.9
15-19	230	24.2
Greater than 20	390	41.1
History of Accidental exposure to blood or blood products	101	10.7
No	849	89.3
Yes		
Sources/Causes of accidental exposure (n=849)		
Injection	617	72.6
Intravenous infusion	232	16.7
Pattern of needle stick injury	34	5.5
Never	128	20.7
Once	187	30.3
Twice	268	43.5
More than two times		

Acceptance of the hepatitis B vaccine was not affected by gender, marital status, income and religion of the healthcare workers in this research.

The statistically significant demographic variables in this research include age and experience of the healthcare workers. Age predicted acceptance of the hepatitis B vaccine. The younger healthcare workers were more likely to have been vaccinated. In the analysis of maximum likelihood estimates, chi-square was 6.58 with probability of 0.1780. Experience in healthcare facilities and acceptance of the hepatitis B vaccine were also correlated (chi-squire: 6.678, probability: 0.58635). Healthcare workers who had worked more than ten years in healthcare facilities were more likely to have had the hepatitis B vaccine than those with less years of experience.

The prevalence of acceptance of HBV vaccination was 79.4%, and of these, 22.5% had completed the required HBV vaccination doses, 56.9% had received at least one dose of vaccine while

20.6 % had not been vaccinated at all. About two-third (65.4%) of the unvaccinated subjects said they would accept vaccination if offered.

The proportion of complete HBV vaccinations increased with job status from 8.3% among the midwifes to 12.8% among the nurses, and 1.45% among the community health assistants. The proportion was also higher among participants with higher level of working experience (Table 2 and).

Table 2:   Prevalence of Hepatitis B Vaccination (n=754)

Variable	Frequency Percentage	Percentage
Completed the required HBV vaccination doses	170	22.5
Had 2 doses of HBV	328	43.5
Had one dose	101	13. 4
Not Vaccinate at all (No dose)	155	20.6
Total	**754**	**100**

Prevalence according to Occupational Status (n=754)						
	Completed		Partially complete		Unvaccinated	
	Freq	%	Freq	%	Freq	%
Midwifes	63	8.3	190	25.1	70	9.3
Nurses	97	12.7	124	16.5	50	6.7
Community Health Assistants	10	1.5	115	15.3	35	4.6
Total	**170**	**22.5**	**429**	**56.9**	**155**	**20.6**

Of the 155 unvaccinated health workers, 65.4% stated that they would consent to vaccination if it were offered. *HBV refusal was primarily related to concern about vaccine side effects (33.2 %), problems with vaccine access/availability (51.5 %,), and* unconvinced about vaccine efficacy (12.2.7%) and no felt need (3.1 %%) (Table 3).

Table 3:   Reasons for refusal to be vaccinated with Hepatitis B (n=196)

Reasons	Frequency	Percentage
Concern about vaccine side effects	65	33.2
Problems with vaccine access/availability	101	51.5
Not sure of/unconvinced about vaccine efficacy	24	12.2
No felt need	6	3.1

Factors that were statistically associated with the acceptance of HBV vaccination included: accidental exposure to blood or blood products, acceptable knowledge about HBV infection, years of work experience, always involved in patient blood transfusion, always exposed to contaminated items, and frequent needle stick injury (Table4).

Table 4:   Predictors of Hepatitis Acceptance

Variable	Frequency	Percentage	OR	95% C
Age				
20-24	420	44.2	1.00	
25-29	530	55.8	2.34	1.26-6.82
Accidental exposure to blood or blood products**				
Yes	812	85.5	4.68	1.56-13.24
No	138	14.5	1.00	
Knowledge of Hepatitis B Epidemiology**				
Yes	784	82.5	4.56	1.48-12.68
No	166	17.5	1.00	
Social & Peer Influence**				
Yes	765	80.5	4.48	1.36-11.88
No	185	19.5	1.00	

Table 4:   Predictors of Hepatitis Acceptance - continued

Unconvinced about vaccine efficacy*				
Yes	252	26.5	1.00	1.26-10.44
No	698	73.5	3.65	
Concerned about vaccine side effects				
Yes	305	22.1	1.00	0.84-7.32
No	645	77.9	3.26	
Problem of Vaccine access*				
Yes	290	30.5	1.00	0.92-8.56
No	660	69.5	3.46	
Always involved in blood transfusion**				
Yes	710	74.7	4.68	1.36-10.66
No	240	25.3	1.00	
Always exposed to contaminated items**				
Yes	800	84.2	4.24	1.48-11.82
No	150	15.8	1.00	

CI=Confidence interval; OR=Odds ratio; ** Factors for acceptance; * Reason for refusal

Variables with a p value of ≤0.05 in the 2 by 2 univariate analysis and biological plausibility were simultaneously analyzed by multiple logistic regression models. After adjusting for all other variables in the model, the results indicated that three variables were statistically associated with acceptance of HBV vaccination: history of accidental exposure to blood or blood products (adjusted odds ratio [OR] 5.38, 95% confidence interval [CI] 1.94-15.16), having acceptable knowledge of HBV infection (adjusted OR 4.82, 95%CI 1.64-12.784), and social & peer influence (physicians, supervisors, role models, friends, and spouse) (adjusted OR 3.66, 95%CI 1.22-10.52) (Table 5)

Table 5:   Crude and adjusted odds ratios from multiple logistic regression analysis of factors relating to HBV acceptance

	Crude		Adjusted	
Variable	**OR**	**95% CI**	**OR**	**95% CI**
Accidental exposure to Blood or blood products				
Yes	4.68	1.56-13.24	5.38	1.94-15.16
No	1.00		100	
Knowledge of Hepatitis Epidemiology				
Yes	4.56	1.48-12.68	4.82	1.64-12.78
No	1.00		100	
Social & Peer Influence				
Yes	4.48	1.36 -11.88	3.66	1.22-10.52
No	1.00		100	

The perceived susceptibility of the respondents regarding hepatitis B virus were measured in five areas; risk of getting hepatitis B, potential seriousness of hepatitis B infection, frequent contact with blood and/or body fluids, needle sticks and splash blood and/or body fluid.

Majority (96.4%) of the sample indicated that they consider themselves as very high and somewhat high risk of getting hepatitis B virus (Table 6).More than three-quarters (78.8%) of the respondents considered themselves as serious potential of hepatitis B infection, while 21.2% of the sample considered themselves as not serious potential seriousness (Table 6).

Table 6:   Perceived susceptibility to Hepatitis B Infection

Questions	**Response**	**Frequency**	**Percentage**	**P-value**
Are you at risk of getting Hepatitis B infection	No risk	1	0.1	0.018
	Not sure	5	0.5	
	Low risk	8	0.8	

Table 6:   Perceived susceptibility to Hepatitis B Infection - continued

	High risk	20	2.2	
	Very High risk	916	96.4	
Do you consider yourself as a serious potential candidate for Hepatitis B infection	Yes (Vey high/High/Low risk)	749	78.8	0.024
	No (No risk/Not Sure)	201	21.2	
What is the frequency of your contact with blood or blood products per day	0-2	684	72	0.062
	More than 2	266	28	
How many needle sticks have you had	1-2	325	34.2	0.046
	Greater than 2	625	65.8	
Have you ever in the past get split blood or blood products in to your eyes, mouth, nose or get blood or blood products into your un-protected skin through cuts	YES	880	92.6	0.036
	No	70	7.4	

More than one-fifth 28% of the respondents indicated that they had more than two times per day of contact with blood and/or blood products in their jobs, however, 72% of the respondents said that they do not have more than two times per day contact with blood and/or blood products. Majority (65.8%) of the respondents indicated that they acquired more than two needle sticks in the past, while, 34.2% of the respondents indicated that they did not have more than 2 needle sticks or they were not sure (Table 6).More than four-fifth (92.6%) of the sample indicated that they had at least one time splash blood or blood products into their mouth, eye, nose, while 7.4% of the sample did not have any splash or they were not sure 9 Table 6).

In his study that there was a significant relationship between the components of perceived susceptibility (risk of getting hepatitis B, potential seriousness of hepatitis B infection, splash blood and/or body fluid) and acceptance of hepatitis B vaccine among healthcare workers (See Table 6).

Perceived Severity vs. Acceptance of Hepatitis B Vaccine. In attempting to examine the relationship of perceived severity of hepatitis B virus and acceptance to hepatitis B vaccine, a cross tabulation comparing responses by variable was performed. Cross tabulation were done using the respondents questioning - how many of the needle sticks in the past were reported and how many of the splash blood or body fluid into the mouth, eyes and nose in the past year were reported to the LGA authority (health workers employer). The study showed that there was no significant relationship between perceived severity and acceptance of hepatitis B vaccine (See Table 7).

Table 7:   Perceived severity by Acceptance of Hepatitis B Vaccine

Question	(Reported)			(Not reported/Not sure)			P-value
	Response	**Frequency**		**Percentage**	**Response**	**Frequency**	**Percentage**
Have you ever in the past get split blood or blood products in to your eyes, mouth, nose or get blood or blood products into your un-protected skin through cuts	Yes	375	88.2	Yes	90	18.9	0.42
	No	100	11.8	No	385	81.1	
How many needle sticks in the past have you reported	Yes	200	42.1	Yes	300	63.2	0.48
	No	275	57.9	No	175	36.8	

Relationship of perceived barriers; safety and effectiveness of hepatitis B vaccine and healthcare workers' acceptance of hepatitis B vaccine was examined by cross tabulation of effectiveness and acceptance questions and it was found that there was a significant relationship between the effectiveness and safety of the hepatitis B vaccine and the acceptance of hepatitis B vaccine (Table 8).

Table 8: Safety and Effectiveness of HBV versus Acceptance of HBV

Question	(Always/Sometimes/Occasionally)			(Never/Not sure)			P-value
	Response	Frequency	Percentage	Response	Frequency	Percentage	
Can somebody get AIDS through HBV	Yes	200	80	Yes	670	95.7	0.012
	No	50	20	No	30	4.3	
HBV is associated with side effects	Yes	130	86.7	Yes	620	80.5	0.028
	No	50	13.3	No	150	19.5	
HBV is effective in reventing Hepatitis B infection in health workers at risk	Yes	740	94.9	Yes	50	29.4	0.014
	No	40	5.1	No	120	70.6	

Discussion

Uptake of hepatitis B vaccination among HCWs is an important public-health issue. Vaccination not only prevents vaccine-preventable diseases, but also decreases the burden on the government by saving the cost for treatment. *The prevalence of acceptance of HBV vaccination was 79.4%, and of these, 22.5% had completed the required HBV vaccination doses and 56.9% were partially vaccinated.* The overall acceptance rate of vaccination was similar to other studies [24, 25,]

Multiple logistic regression analysis revealed that, after controlling for all other variables in the model, only three variables were significantly related to acceptance of HBV vaccination: history of accidental exposure to blood or blood products, acceptable knowledge about HBV infection, and *social & peer influence (Clinicians, supervisors, role models, friends, and spouse)*

The study revealed that the odds of acceptance of HBV vaccination among health workers who were accidentally exposed to blood or blood products was 5.38 times higher than for those that were not accidentally exposed. A possible reason for this could be that health workers who were exposed might be more conscious about HBV infection and its prevention after exposure to patient's blood than those that were not exposed. Accidental exposure might change mindset of health workers towards acceptance of HBV vaccination. The finding from this study is similar to that of Techapetpibul *et al*[26] who reported that exposure to patient blood was associated with acceptance of HBV vaccination by health workers.

Health workers with acceptable knowledge of HBV infection had 4.82 odds of acceptance of HBV vaccination than health workers with unacceptable knowledge. This is possible because the knowledge of HBV infection and HBV vaccination encouraged positive attitudes which help to maintain their beliefs in the safety and efficacy of vaccine. In addition, the health workers seem to believe and have trust in the information given to them by their teachers and colleagues in school. This result was also consistent with the findings of McGrane and Staines who reported that obtaining information relating to the benefits of vaccine from an occupational health physician or from a nurse was a significant factor in acceptance of vaccine[27] and that of Bradley and Kristi who found out that acceptance of HBV vaccine was strongly related to knowledge of HBV disease and HBV vaccination[28].

This study also revealed that the odds of acceptance of HBV vaccination for health workers who has a colleague or friend vaccinated with HBV were 3.66 times higher than those who do not have a colleague or friend already vaccinated with HBV. This could be as a result of peer pressure.

The majority of the respondents consistently answered the knowledge questions correctly. The percentage of healthcare workers in this study who have had the required doses of hepatitis B vaccine is considerably lower than that reported in the literature for all healthcare workers. The variable of perceived severity was not a predictor of hepatitis B vaccine acceptance; the variables of perceived susceptibility and knowledge level were predictors of hepatitis B vaccine acceptance. Also, a significant relationship was found between age and experience and the acceptance of the hepatitis B vaccine.

In this study younger healthcare workers were found more likely to have been vaccinated withr HBV and this may be related to the younger healthcare workers' expectations of remaining in in the job

for more years than older healthcare workers. In fact, the healthcare workers with more experience were significantly more likely to have been vaccinated. Fear concerning the safety and effectiveness of the HBV vaccine was a major reason for non-acceptance of HB vaccine. Whereas, those respondents that accepted HB vaccine indicated that hepatitis B vaccine is very safe and effective.

Healthcare workers need to be aware of the greater likelihood that they may be HB carriers compared to the general population; therefore they are at risk for occupational exposure to HBV when their position involves giving injections, treating injuries, and performing phlebotomies. Increasing perceived susceptibility can be addressed through the professional competence and educational seminars for healthcare workers.

Further research on the issue of the HB vaccine acceptance among healthcare workers might focus on subgroups with high acceptance of HB vaccine, as in this study. Variables within the framework of the health belief model could be analyzed, particularly perceived susceptibility. Other instruments, such as the locus of control scales, or those which measure psychosocial variables were not measured in this study, might provide insight into reasons for taking the health action of acceptance of the HB vaccine.

Another approach is to research health facilities in which the HB vaccine acceptance rate is high and compare it to those in which the HB vaccine acceptance rate is low. Differences in variables, using the HBM or other frameworks, might provide further insight into the significant variables associated with acceptance of the HB vaccine. Also research is needed to ascertain whether education about HBV infection and vaccination is effective in modifying acceptance of the vaccine. Educational sessions incorporated as part of vaccine programs should ensure that persons who are candidates for vaccination have access to complete and accurate information. However, the proper formation of beliefs regarding the safety and efficacy of vaccine may be the most important factor in determining vaccine acceptance.

Limitations of the Study: This study has the following limitations. (1).The study was conducted among health workers in rural Primary health care centers, the results may not be generalizable to other health workers in other primary health care facilities; (2). The study relied on self-reported data; however, self-reported data have been shown to have an acceptable sensitivity and specificity when investigating the vaccine coverage in the general population [29]; and (3). The study design was cross-sectional, therefore the results cannot be used for establishing a causal relationship. A follow-up study will help to overcome these limitations.

Conclusion

The proportion of health workers that had completed the required doses of HBV in this study was very low and is unacceptable. All health workers should be required to be regularly vaccinated with hepatitis B vaccine both prior and after commencement of work. Health education on HBV and effective intervention programmes (e.g. regualar on-the-job training) should be designed to increase awareness relating to hepatitis infection and HBV safety. Adhering to universally-accepted precautions should always be made compulsory.

References

[1]   Hadler SC. Hepatitis B virus infection and health care workers. *Vaccine* 1990;8(Suppl):S24-8; discussion S41-3.

[2]   Gerberding JL. The infected health care provider. *N Engl J Med* 1996 29;334:594-5.

[3]   Gunson RN, Shouval D, Roggendorf M, Zaaijer H, Nicholas H, Holzmann H *et al*. Hepatitis B virus (HBV) and hepatitis C virus (HCV) infections in health care workers (HCWs): guidelines for prevention of transmission of HBV and HCV from HCW to patients. *J Clin Virol* 2003;27:213-30.

[4]   Weinbaum CM, Williams I, Mast EE, Wang SA, Finelli L, Wasley A, Neitzel SM, Ward JW (2008) Recommendations for Identification and Public Health Management of Persons with Chronic Hepatitis B Virus Infection. MMWR 57: 1-20.

[5]   Souza KP, Luz JA, Teles SA, Carneiro MA, Oliveira LA, Gomes AS, Dias MA, Gomes SA, Yoshida CF, Martins RM (2003) Hepatitis B and C in the Hemodialysis Unit of Tocantins, Brazil: Serological and Molecular Profiles. Menorias do Instituto Oswaldo Cruz 98: 599-603.

[6]   World Health Organisation (2009) Hepatitis B Fact sheet NO204. Accessed 10 June 2009. Available: http://www.who.int/csr/disease/hepatitis.

[7]   Forbi JC, Onyemauwa N, Gyar SD, Oyeleye AO, Entonu P, Agwale SM (2008) High prevalence of hepatitis B virus among female sex workers in Nigeria. *Rev Inst Trop Sao Paulo*; 50: 219-221.

[8]   Onyekwere CA, Anomneze EE, Wali SS (2002) Prevalence of serological markers of chronic hepatitis B virus infection in diabetes in the Lagos University Teaching Hospital, Lagos. Niger Postgrad Med J 9: 129-133.

[9]   Adoga MP, Banwat EB, Forbi JC, Nimzing L, Pam CR, Gyar SD, Agabi YA, Agwale SM (2009) Human Immunodeficiency Virus, Hepatitis B Virus and Hepatitis C Virus: Sero-prevalence, Co-infection and Risk Factors among Prison inmates in Nasarawa State, Nigeria. J Infect Dev Ctries 3: 539-547.

[10]   World   Health   Organization: *Hepatitis   B.   Fact   sheet   no: 204*. http://www.who.int/mediacentre/factsheets/fs204/en.

[11]   EASL International Consensus Conference on Hepatitis B, 13-14 September, 2002, Geneva, Switzerland (2003) Consensus Statement. Journal of Hepatology 38: 533-540.

[12]   Otegbayo JA, Fasola FA, Abja A (2003). Prevalence of Hepatitis B surface and e antigens, risk factors for viral acquisition and serum transaminase among blood donors in Ibadan, Nigeria. Trop Gastroenterol 24: 196-197.

[13]   Lavanchy D. Hepatitis B virus epidemiology, disease burden,treatment and current and emerging prevention and control measures. J Viral Hepat 2004; 11: 97-104

[14]   Fakunle YM, Abdurahman MB, Whittle HC: **Hepatitis B virus Infection in Children and Adults in Northern Nigeria: a preliminary Survey.** *Trans Roy Soc Trop Med Hyg* 1981, 75:626-629.

[15]   Abiodun PO, Omoike IU: **Hepatitis B surface Antigenaemia in children in Benin City Nigeria.** *Nig J Paediatr 1990*, 17:27-31.

[16]   Ayoola EA, Adelaja AB: **Sub-determinants and incidence of Hepatitis B antigen in carriers of HBsAg.** *Nig Med Practitioner* 1986, 11(5/6):133-136.

[17]   Olumide EA: **The distribution of HbsAg in Africa and the Tropics: Report of a population study in Nigeria.** *Int J Epidemiol* 1976, 5(3):279-289.

[18]   Kim WR, Brown RS, Terrault NA, El-Seragg HH: **Burden of liver disease in the United States: summary of a worhshop.** *Hepatology* 2002, 36:227-242.

[19]   Ugwuja EI: **Seroprevalence of Hepatitis B surface Antigen and liver function tests among adolescents in Abakaliki, South Eastern.** *Internet Journal of Tropical Medicine* 2010, **6**(2)**:**1-6.

[20]   Shahnaz S, Reza B, Seyed-Moayed A: **Risk factors for chronic Hepatitis B infection: a case controlled study.** *Hepatitis Monthly* 2005, 5(4):109-115.

[21]   Seyed-Moayed A: **Immunization, an important strategy to control hepatitis.** *Hepatitis monthly* 2006, **6**(1):3-5.

[22]   Sadoh AE, Eregie CO: **Age at presentation for infant immunization in Nigeria: Implications for Hepatitis B immunization.** *Public Health* 2008, **22:**1318-1320.

[23]   Odusanya OO: **Hepatitis B Virus (HBV) vaccine - the Nigerian Story.** *IFEMED Journal* 2008, **14**(1):4-5.

[24]   Lin WC, Ball C. Factors affecting the decision of nursing students in Taiwan to be vaccinated against hepatitis B infection. *J Adv Nurs* 1997;25:709-18.

[25]   Hafeez-ur-Rehman Mengal, Nopporn Howteerakul, Nawarat Suwannapong2,and Thitipat Rajatanun. Factors Relating to Acceptance of Hepatitis B Virus Vaccination by Nursing Students in aTertiary Hospital, Pakistan J HEALTH POPUL NUTR 2008 Mar;26(1):46-53.

[26]   Techapetpibul K, Kamolratanakul P, Ungthavorn P. Acceptance of hepatitis B vaccination by nursing personnel in an area hyperendemic for hepatitis B. *Chula Med J* 1992;36:411-6.

[27]   McGrane J, Staines A. Nursing staff knowledge of the hepatitis B virus including attitudes and acceptance of hepatitis B vaccination. Development of an effective program. *AAOHN J* 2003;51:347-52.

[28]   Bradley N, Kristi J. Predictors of hepatitis B vaccine acceptance in health care workers. *Med Care* 1996;34:58-72.

FPGA Implementation of Matrix-Vector Multiplication for Image Processing Application

A. Senthil Rajan

Director, Computer Centre, Alagappa University, Karaikudi
E-mail: agni_senthil@yahoo.com

Abstract

Matrix-vector multiplication is a computationally intensive and kernel operation used in many image processing applications. This paper presents a preliminary Field Programmable Gate Array (FPGA) design and implementation of dense matrix-vector multiplication for use in an image processing application. The design is optimized for speed which is the main requirement for such applications. The design has been implemented on Virtex-4 FPGA using Xilinx ISE 9.2i and the performance is evaluated by computing the execution time on FPGA. FPGA implementation results demonstrate that it can provide a maximum throughput of 16970 frames per second utilizing only 14% Virtex-4 slices and 57% DSP48 blocks which is quite adequate for most real-time image processing applications.

Index Terms   Field Programmable Gate Array (FPGA), Hardware Implementation, Image Processing, Matrix-Vector multiplication.

I. Introduction

Computationally intensive algorithms used in image and signal processing, multimedia, telecommunications, cryptography, networking and high performance computing (HPC) domains in general were first realized using software running on Digital Signal Processors (DSPs) or General Purpose Processors (GPPs). Significant speed–up in computation time can be achieved by assigning complex computation intensive tasks to hardware and by exploiting the parallelism in algorithms [1]. Recently, Field Programmable Gate Arrays (FPGAs) have emerged as a platform of choice for hardware implementation of computation intensive algorithms [1]–[13]. Especially, when the design at hand requires very high performance, designers can benefit from high density and high performance FPGAs instead of costly multicore Digital Signal Processing (DSP) systems. FPGAs enable a high degree of parallelism and can achieve orders of magnitude speedup over GPPs [7]. This is as a result of the increasing embedded resources on FPGA. FPGA have the benefits of the hardware speed and the software flexibility; also they have a price/performance ratio much more favorable than Application Specific Integrated.

Circuits (ASICs). Since the major resources for implementing computation intensive algorithms are embedded on FPGA, latency associated with device communication has been eliminated. However, these embedded resources are limited hence it is important to use these resources efficiently. The last decade has seen ever increasing application areas for FPGAs. Modern FPGAs currently accommodate more than ten million gates with clock rates up to 600 MHz [13]. Example application areas include single chip replacements for old multichip technology designs, DSP, image processing, multimedia applications, high–speed communications and networking equipment such as routers and switches, the

implementation of bus protocols such as Peripheral Component Interconnect (PCI), microprocessor glue logic, coprocessors and controllers [13]. Most of the computation intensive algorithms such as those used in image processing application involve dense or sparse matrix–vector multiplication as the kernel operation. It has been implemented using novel algorithms and technologies to achieve high performance [14]. In this paper, we present a preliminary design and FPGA implementation of dense matrix–vector multiplication for use in an image processing application. The remainder of this paper is organized as follows. Section II presents a brief overview of the FPGA technology. The mathematical formulation of the design is presented in section III. Section IV presents the hardware design and FPGA implementation results of the matrix–vector multiplier. Finally, concluding remarks and scope for future work are discussed in section V.

II. FPGA Technology Overview

FPGAs are digital integrated circuits (ICs) that belong to a family of programmable logic devices (PLDs). An FPGA chip includes Input Output Blocks (IOBs) and the core programmable fabric. The IOBs are located around the periphery of the chip, providing programmable I/O connections and support for various I/O standards. The core programmable fabric consists of programmable logic blocks also called Configurable Logic Blocks (CLBs) and programmable routing architectures. Many different architecture and programming technologies have evolved to provide better designs that make FPGAs economically viable and an attractive alternative to ASICs. Modern FPGAs have superior logic density, low chip cost and performance specifications comparable to low end microprocessor. With multimillion programmable gates per chip, current FPGAs can be used to implement digital systems capable of operating at frequencies up to 600 MHz. In many cases, it is possible to implement an entire system using a single FPGA. This is very economical for specialized applications that do not require the performance of custom hardware. Significant technological advancements have led to architectures that combine FPGA's logic blocks and interconnect matrices, with one or more microprocessors, embedded Intellectual Property (IP) cores, memory blocks, DSP blocks integrated on a single chip to facilitate the implementation of Programmable System–on–a–Chip (PSoC) designs. Examples of PSoC are the Xilinx Virtex–II Pro, Virtex–4, Virtex–5 and Virtex–6 FPGA families, which include one or more hard-core PowerPC processors embedded along with the FPGA's logic fabric . Alternatively, soft processor cores that are implemented using part of the FPGA logic fabric are also available. Many soft processor cores are now available such as: Xilinx 32–bit MicroBlaze and PicoBlaze, and the Altera Nios and the 32–bit Nios II processor.

III. Mathematical Formulation

Matrix–vector multiplication is computationally intensive and typical routine used in many image processing applications. It requires several multiply and accumulate (MAC) units. In DSPs, the overall performance is limited by the number of multiplications and additions that could be done in parallel. DSPs take several clock cycles to perform all the necessary MAC operations. However, modern FPGAs, on the other hand are equipped with large number of hardware resources embedded in the FPGA fabric itself such as DSP48 blocks, multipliers, Block RAMs, etc . It can provide higher and more efficient processing rates required by such applications if the algorithm is coded in a way to utilize these embedded resources efficiently. The objective of this paper is to realize a large and dense matrix–vector multiplier for an image processing application. We represent the vector C as (C1, C2...Cm)T and vector G which represents the image data. According to the application, we want to multiply matrix S with vector C represented by the following equation

$$C = SG \qquad\qquad (1)$$

where, S is a Jacobian matrix. In the discrete form, it is required to find the unknown vector G from the known vector C, while S is treated as a constant matrix for simplicity. We can represent G by the following relationship

G=STC   (2)

where, ST is the transpose of S. Replacing ST by A, mathematically; the above equation is approximated by the following relationship

G=AC   (3)

The key idea here is to calculate G using (3). The dimension of the given matrices depends on the application, which, in this case is summarized in table 1.

Table 1:   Matrix Dimensions

Matrix Symbol	Matrix Dimension
A	1024×28
C	28×1
G	1024×1

IV. Hardware Design and FPGA Implementation

In this section, we present the details of the hardware design for implementing matrix–vector multiplication on FPGA. As can be seen from (3), the image processing algorithm reduces to matrix–vector multiplication. For efficient implementation and maximum speed-up, integer arithmetic is utilized. Since the floating–point arithmetic unit consumes more silicon real estate of FPGA and are slower as compared to integer arithmetic, we used integer arithmetic for the design. The design involves the computation of $G = AC$, where A is a matrix, C and G are vectors as summarized in table 1. It is required to calculate vector G. The matrix–vector multiplication is performed by broadcasting rows of matrix A and multiplying the corresponding column elements of vector C . The sequence of operations involved in the computation of matrix–vector multiplication is as follows:

1) Reading the individual row elements of matrix A and the individual column elements of vector C.
2) Storing them in internal buffers row and column wise respectively.
3) Multiplying the row and column elements.
4) Accumulating the multiplier output and writing back the results to the output buffers.

The input and output buffers are implemented on the FPGA. The matrix–vector multiplication typically involves MAC operations. The MAC unit consists of a multiplier and accumulator. The row and the column elements are supplied as the two inputs to the multiplier. The output of the multiplier is directly given to the accumulator as one of the inputs. The previous output of the accumulator is fed back as the second input. The MAC unit takes each element of the matrix A in row major format and each element of vector C, multiplies them and adds the result to the running total. This process is repeated till the last element of row A and column C. The values are fed in a sequential manner. If the reset signal is asserted high, the contents of registers A and C are cleared. After a delay, as determined by the implementation results, the first element of vector G is available at the serial output and this output is stored in on–chip memory as shown in figure 1. This operation is repeated and the process continues until all the rows of matrix A are processed. Finally, the output vector G is available with all the elements stored in the memory locations. A simplified diagram of the processing element for matrix–vector multiplication is shown in figure 1. Figure 2 presents the simulation result for matrix–vector multiplication using Xilinx edition ModelSim XE III 6.4b simulator.

In order to evaluate the performance of FPGA–based implementation, the algorithm was coded in VHDL and implemented on Virtex–4 (xc4vlx200ff1513, speed grade: –11) family using Xilinx ISE 9.2i tool. The design was synthesized into Virtex–4 FPGA optimized for speed. The hardware resource utilization is summarized in table 2.

As shown in table 2, 14% of the slices and 57% DSP48s are utilized leaving a plenty of room to implement more parallel processors on the same FPGA chip. The results listed in table 2 were obtained using Xilinx ISE 9.2i tool. The optimization setting for ISE is for maximum clock speed. The total

processing time using Virtex–4 FPGA is found to be 58.93 µs; this is equivalent to a throughput of 16970 frames per second. The results indicate the feasibility of using FPGA for real–time high speed image processing applications using this matrix–vector multiplication.

Resources	Used/Available	Utilization
Slices	1,3010 out of 89088	14%
Four-input LUTs	9612 out of 178176	5%
DSP48s	55 out of 96	57%
Maximum Frequency	17.376 (MHz)	-
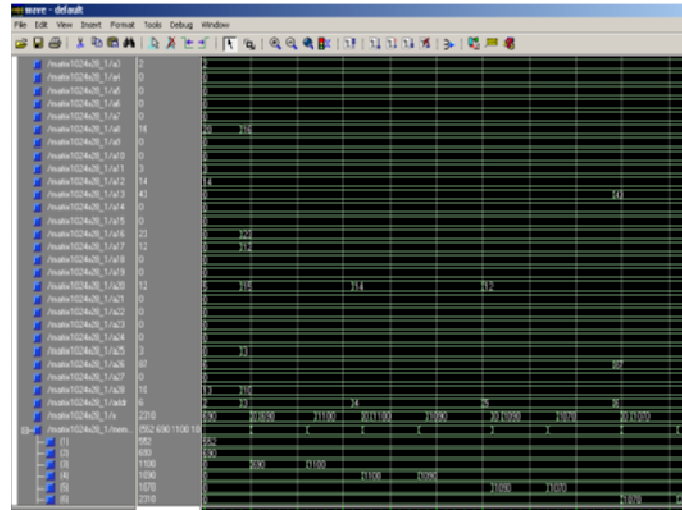
V. Conclusions and Future Work

Most of the algorithms which are used in DSP, image and video processing, computer graphics and vision and high performance supercomputing applications have matrix operation as the kernel operation. In this paper, we have presented a preliminary design of dense matrix–vector multiplication. The design has been implemented on a Xilinx Virtex–4 FPGA device and the performance is evaluated by computing its execution time on FPGA. Hardware implementation results demonstrate that it can provide a throughput of 16970 frames per second which is sufficient for many real–time image and video processing applications. Some recommendations to continue this work in future are outlined below:

1) Implementing the architecture of matrix–vector multiplication using floating point arithmetic instead of integer. This will further enhance the design by making it suitable for other high performance computing applications, where the current trend is to use double precision floating point numbers.

2) FPGA–based standalone module is presented to enhance the computation time of the matrix–vector multiplication. However, the communication time between the FPGA coprocessor and host PC is not taken into consideration. The introduction of parallel and/or pipelined coprocessor along with an embedded processor of FPGA can reduce the computational time depending on the level of parallelism introduced.

3) Exploration of domain–specific Coarse Grained Reconfigurable Architecture (CGRA) for implementing computationally intensive matrix–vector multiplication.

References

[1]   S. Ogrenci, A. K. Katsaggelos, and M. Sarrafzadeh, "Analysis and FPGA Implementation of Image restoration under resource constraint," IEEE Trans. on Computers, Vol. 52, No. 3, pp. 390-399, 2003.

[2]   C. Ebeling, C. Fisher, G. Xing, M. Shen, and H. Liu, "Implementing an OFDM Receiver on the RaPiD Reconfigurable Architecture," IEEE Trans. on Computers, Vol. 53, No. 11, pp. 1436-1448, 2004.

[3]   G. R. Goslin, "A Guide to Using Field Programmable Gate Arrays for Application-Specific Digital Signal Processing Performance," Microelectronics Journal, Vol. 28, Issue 4, pp. 24-35, 1997.

[4]   J. Isoaho, J. Pasanen, O. Vainio, and H. Tenhunen, "DSP System Integration and Prototyping with FPGAs," Journal of VLSI Signal Processing, Vol. 6, pp. 155-172, 1993.

[5]   A. G. Ye and D. M. Lewis, "Procedural Texture Mapping on FPGAs," in Proc. of ACM/SIGDA 7th Intl. Symp. on Field Programmable Gate Arrays, pp. 112-120, 1999.

[6]   S. Knapp, "Using Programmable Logic to Accelerate DSP Functions," http://www.xilinx.com/appnotes/dspintro.pdf.

[7]   J. Ma, "Signal and Image processing via Reconfigurable Computing," in Proc. of the First Workshop on Information and Systems Technology, 2003.

[8]   F. Otto and Z. Pavel, "Hardware Accelerated Imaging Algorithms," in Proc. of AUTOS'2002 Automatizace systému, pp. 165-171, 2002.

[9]   L. Batina, S. B. Ors, B. Preneel, and J. Vandewalle, "Hardware architectures for public key cryptography," Integration, the VLSI Journal, Vol. 34, pp. 1-64, 2003.

[10]   D. Johnson, K. Gribbon, D. Bailey, and S. Demidenko, "Implementing Digital Signal Processing Algorithm's in FPGA's: Digital Spectral Warping," in Proc. of 9th Electronics New Zealand Conf., pp. 72-77, 2002.

[11]   K. Compton and S. Hauck, "Reconfigurable Computing: A Survey of Systems and Software," ACM Computing Surveys, Vol. 34, No. 2, pp. 171-210, 2002.

[12]   R. Tessier and W. Burleson, "Reconfigurable Computing for Digital Signal Processing: A survey," Journal of VLSI Signal Processing, Vol. 28, No. 3, pp. 7-27, 2001.

[13]   T. J. Todman, G. A. Constantinides, S. J. E. Wilton, O. Mencer, W. Luk, and P. Y. K. Cheung, "Reconfigurable Computing: architectures and design methods," IEE Proc. of Computer Digital Techniques, Vol. 152, No. 2, pp. 193-207, 2005.

[14]   N. Fujimoto, "Faster matrix-vector multiplication on GeForce 8800GTX," in Proc. of the 22nd IEEE Intl. Parallel and Distributed Processing Symposium (IPDPS), pp. 1-8, 2008.

Design and Simulation of a Coded OFDM Modulation Technique Based on Discrete Wavelet Transform

Saad Saffah Hreshee
Electrical Eng. Dept., College of Engineering, Babylon University
E-mail: saadalkhazali@yahoo.com

Defaf Talal Shakir
MSc Student, Electrical Eng. Dept, College of Engineering, Babylon University

Abstract

Multicarrier modulation techniques such as OFDM are used to overcome multipath fading and Inter symbol Interference (ISI) in single carrier systems, where the data stream to be transmitted is divided into several lower rate data streams each being modulated on a subcarrier. To avoid ISI, a small interval, known as the guard time interval, is inserted into OFDM symbols. The length of the guard time interval is chosen to exceed the channel delay spread. Therefore, OFDM can combat the multipath fading and eliminate ISI almost completely.

Another problem is the reduction of the error rate in transmitting digital data. For that an error correcting Codes was used in the proposed OFDM system which is suitable for high data rate transmission combined with channel coding scheme for improving reliability of system. These systems called Coded Orthogonal Frequency Division Multiplexing (COFDM) systems.

This paper prove that the COFDM systems are capable to achieve excellent performance on frequency selective channels because of the combined benefits of multicarrier modulation and coding.

The aim of this work is to propose a DWT-COFDM system and to compare the results of this system with FFT-OFDM, DWT-OFDM and FFT-COFDM with respect to BER performance under the effect of AWGN, Flat Fading and Selective Fading channels.

Keywords: OFDM, COFDM, Wavelet Transform, DWT, AWGN, Flat Fading and Selective Fading.

1. Introduction

ORTHOGONAL Frequency Division Multiplexing (OFDM) system is one of the most promising technologies for current and future wireless communications. OFDM has grown to be the most popular communications systems in high speed communications in the last decade [1]. It is a modulation scheme that allows digital data to be efficiently and reliably transmitted over a radio channel, even in multipath environments.

OFDM transmits data by using a large number of narrow bandwidth carriers [2]. These carriers (subcarriers) have different frequencies and they are orthogonal to each other [3]. Two signals are orthogonal if their dot product is zero. That is, if you take two signals multiply them together and if their integral over an interval is zero, then two signals are orthogonal in that interval.

Orthogonality can be achieved by carefully selecting carrier spacing, such as letting the carrier spacing be equal to the reciprocal of the useful symbol period. [2, 4].

Mathematically [2, 4], suppose that F represents a set of signals, where F_p is the pth element in the set. The signals are orthogonal if:

$$\int_a^b F_p(t)F_p^*(t)dt = \begin{cases} K & for \quad p=q \\ 0 & for \quad p \neq q \end{cases}$$

(1)

Where the (*) indicates the complex conjugate and interval [a, b] is a symbol period. Mathematically, each carrier can be described as a complex wave:

$$S_c(t) = A_c(t)e^{j[\omega_c t + \varphi_c(t)]}$$

(2)

The real signal is the real part of $S_c(t)$. Both $A_c(t)$ and $\phi_c(t)$, the amplitude and phase of the carrier respectively, can vary on a symbol by symbol basis. The values of the parameters are constant over the symbol duration period T_s. OFDM consists of many carriers. Thus the complex signals $S_s(t)$ is represented by equation (3), and shown in Figure (1):

$$S_s(t) = \frac{1}{N}\sum_{n=0}^{N-1} A_n(t)e^{j[\omega_n t + \varphi_n(t)]}$$

(3)

Where $\omega_n = \omega_0 + n\Delta\omega$

(4)

This is of course a continuous signal. If the waveforms of each component of the signal is considered over one symbol period, then the variables $A_c(t)$ and $\phi_c(t)$ take on fixed values, which depend on the frequency of that particular carrier, and so can be rewritten:

$$\varphi_n(t) \Rightarrow \varphi_n$$
$$A_n(t) \Rightarrow A_n$$

(5)

Figure 1: Examples of OFDM spectrum (a) a single sub-channel, (b) 5 carriers, so that at the central frequency of each sub-channel, there is no crosstalk from other sub-channels.

(a)   (b)
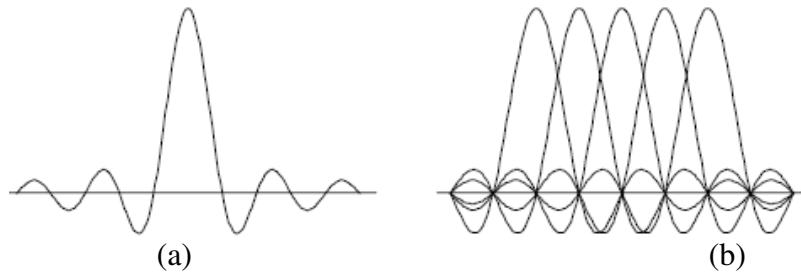
If the signal is sampled using a sampling frequency of *1/T*, then the resulting signal is represented by:

$$S_s(kT) = \frac{1}{N}\sum_{n=0}^{N-1} A_n e^{j[\omega_0 + n\Delta\omega)kT + \varphi_n]}$$

(6)

At this point, the restriction of the time over which the analysis of the signal to N samples should be done. It is convenient to sample over the period of one data symbol, so that

$$T_s = NT$$

(7)

Simplifying equation (6), without a loss of generality by letting ω0=0, then the signal becomes:

$$S_s(kT) = \frac{1}{N}\sum_{n=0}^{N-1} A_n e^{j\varphi_n} e^{j(n\Delta\omega)kT}$$

(8)

Now equation (8) can be compared with the general form of the inverse Fourier transform:

$$g(kT) = \frac{1}{N} \sum_{n=0}^{N-1} G(\frac{n}{NT}) e^{j2\pi nk/n} \tag{9}$$

In equation (8), the function $A_n e^{j\varphi_n}$ is no more than a definition of the signal in the sampled frequency domain, and $S_s(kT)$ is the time domain representation. Equations (8) and (9) are equivalent if

$$\Delta f = \frac{\Delta \omega}{2\pi} = \frac{1}{NT} = \frac{1}{T_s} \tag{10}$$

This is the condition that required for orthogonality [2].

Coded OFDM (COFDM) is a term used for a system in which the error control coding and OFDM modulation processes work closely together. COFDM, systems are able to achieve excellent performance on frequency selective channels because of the combined benefits of multicarrier modulation and coding.

COFDM is the same as OFDM except that forward error correction is applied to the signal before transmission. This is to overcome errors in the transmission due to lost carriers from frequency selective fading, channel noise and other propagation effects [5].

2. OFDM System Model

The general block diagram of orthogonal frequency division multiplexing is shown in figure (2). The input data stream is first mapped to complex data symbols according to a given constellation, 4-QAM, 16-QAM, 32-QAM and so on. The amount of data transmitted on each subcarrier depends on the constellation, 4-QAM and 16-QAM transmit two and four data bits per subcarrier, respectively. After symbol mapping, it is necessary to convert the data stream into parallel form where each parallel data stream represents a sub-channel, so a serial to parallel converter is used. The Inverse Fast Fourier Transform (IFFT) is then taken to convert the signals from the frequency domain to the time domain, an IFFT converts a number of complex data points, of length that is power of 2, into the same number of points but in the time domain. The output data from the IFFT is then converted from parallel to serial and a cyclic prefix is added. The addition of a cyclic prefix to each symbol solves for both the Inter Symbol Interference and Inter Carrier Interference.

In the receiver the whole process is reversed to recover the transmitted data. The analog signal is digitized and re-sampled by the Analog to Digital Converter (ADC).The cyclic prefix is removed. After the cyclic prefix removal, the signal goes through a serial to parallel converter. The FFT of each symbol is then taken to convert the time domain signal to frequency domain. The signal is then converted from parallel to serial and it is then passed through a De-mapping block to recover the original signal [6, 7, and 8].

Figure 2: Block diagram of the FFT based OFDM
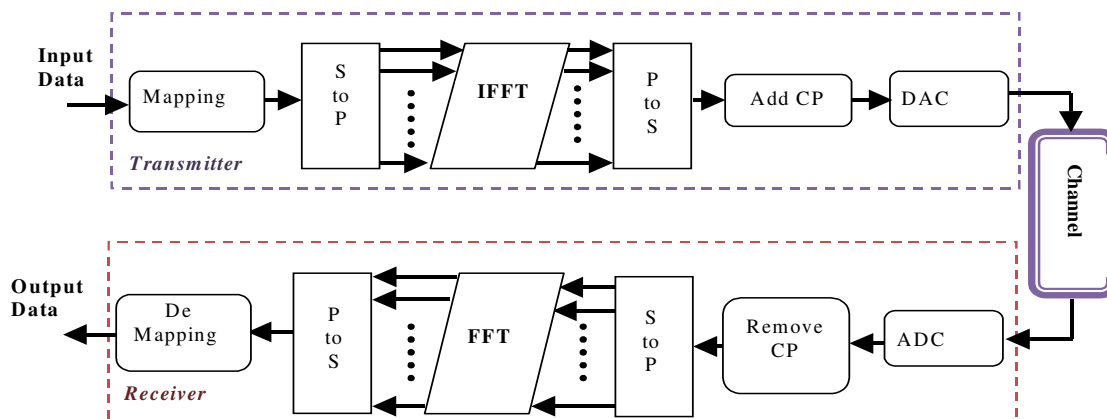
3. Wavelet Based OFDM

A wavelet is a waveform of effectively limited duration that has an average value of zero. The comparative difference between wavelets and sine waves, which are the basis of Fourier analysis is that sinusoids do not have limited duration, they extend from minus to plus infinity and where sinusoids are smooth and predictable, wavelets tend to be irregular and asymmetric. As the well-known technique of signal analysis Fourier analysis consists of breaking up a signal into sine waves of various frequencies, similarly, wavelet analysis is the breaking up of a signal into shifted and scaled versions of the original (or mother) wavelet. Wavelets have numerous applications in digital communications. Orthogonal frequency division multiplexing (OFDM) is one of them [2, 9].

In a DWT based system, the inverse discrete wavelet transform (IDWT) and discrete wavelet transform (DWT) replace the IFFT and FFT of FFT-OFDM system in modulation and demodulation processes as shown in figure (3) [9].

One of the advantages of using wavelet transform is that due to the overlapping nature of wavelet properties, the wavelet based OFDM does not need cyclic prefix to deal with delay spreads of the channel. As a result, it has higher spectral containment than that of Fourier-based OFDM. The input data is processed as per FFT-OFDM. However, the difference is that the system does not require CP to be added to the OFDM symbol [9].

Figure 3: Block diagram of the DWT based OFDM.
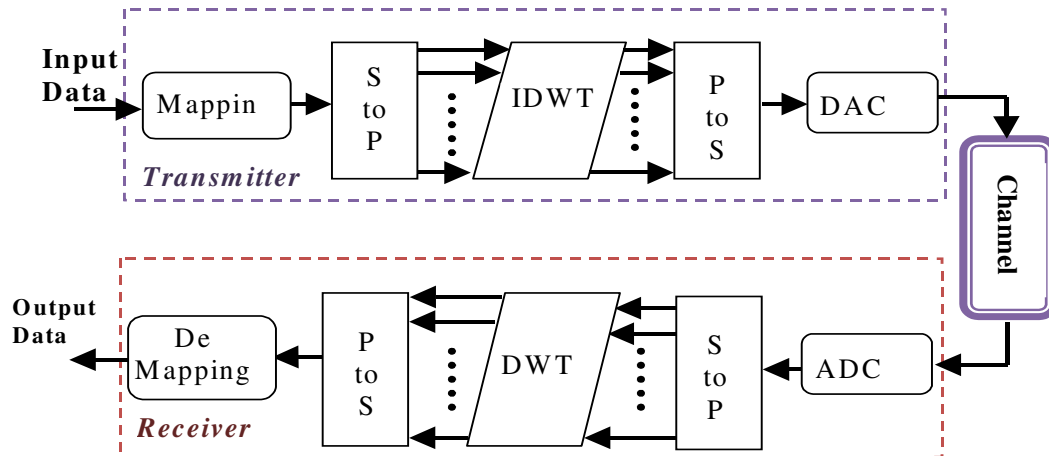
4. DWT-Cofdm System Model

Error control codes have become a vital part of modern digital wireless system; enabling reliable transmission to be achieved over noisy channels. OFDM which is suitable for high data rate transmission is combined with FEC methods called Coded OFDM (COFDM) which enables the OFDM system to enhance the system throughput. In Wireless communication systems main challenge is to provide high data rate environment and reliable transmission so channel coding scheme is essential for improving reliability of transmission [10].

The general block diagram of DWT-COFDM system is shown in figure (4). In COFDM at transmitter side input data is coded via FEC encoder and interleaving is used which will enhance the performance of OFDM system because of its ability to overcome the effect of burst errors and fading type errors, then the modulated signal is transmitted via IDWT. At receiving side signal is demodulated, de-mapped, de-interleaved and then decoded via FEC decoder to recover the transmitted information[10].

There are two different types of FEC techniques, namely block codes and convolutional codes. In this paper convolution code is used.

Convolutional codes are extensively used for real time error correction. Convolutional coding is done by combining the fixed number of input bits. The input bits are stored in fixed length shift register and they are combined with the help of mod-2 adders. An input sequence and contents of shift registers perform modulo-two addition after information sequence is sent to shift registers, so that an output sequence is obtained. This operation is equivalent to binary convolution and hence it is called convolutional coding [11].

The ratio *R=k/n* is called the code rate for a convolutional code where *k* is the number of parallel input bits and *n* is the number of parallel decoded output bits, *m* is the symbolized number of shift registers. Shift registers store the state information of convolutional encoder, and constraint length (*K*) relates the number of bits upon which the output depends. The constraint length, *K*, of the convolutional encoder is defined by *K=m+1*, where m is the maximum number of memories in any convolutional encoder [11].

Figure 4: Block diagram of the DWT based COFDM
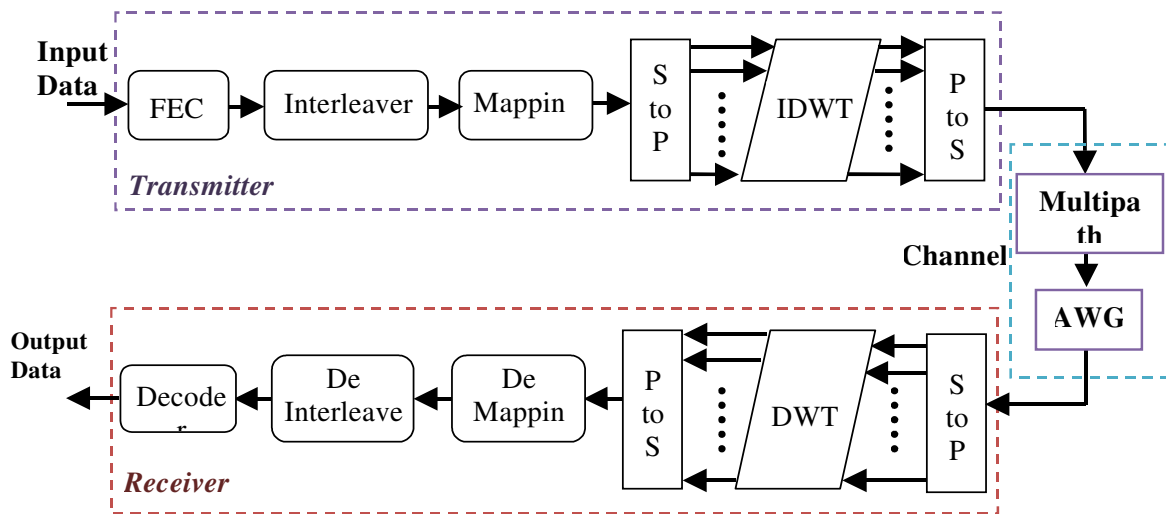
5. Simulation Results of the Proposed System

In this section the simulation of the proposed DWT-COFDM system in MATLAB are achieved. And the bit error rate (BER) performance of the COFDM system considered in different channel models, the additive white Gaussian noise (AWGN) , the flat fading , and the selective fading channel. Table (1) shows the parameters of the system that are used in the simulation.

Table 1:   Simulation Parameters

Parameter	Value
Modulation type	16_QAM
Channel Model	AWGN
	Flat Fading
	Selective Fading
Number Of Frames	1000
Coding	Convolution Code
Doppler Frequency	4HZ and 80HZ
FFT or DWT Size	64
Number of data subcarriers	48
Number of pilot subcarriers	4
Number of total subcarriers	52

5.1. BER Performance of DWT-COFDM in AWGN Channel

In this section, the result of the simulation for the DWT-COFDM system is calculated and shown in figure (5), which gives the BER performance of DWT-COFDM in AWGN channel. It is shown clearly that the DWT-COFDM is much better than the three previous systems FFT-OFDM, FFT-COFDM and DWT-OFDM.

Table 2: BER comparison of FFT-OFDM, DWT-OFDM, FFT-COFDM and DWT-COFDM in AWGN channel.

	FFT-OFDM		**DWT-OFDM**		**FFT-COFDM**		**DWT-COFDM**	
BER	10^{-3}	10^{-4}	10^{-3}	10^{-4}	10^{-3}	10^{-4}	10^{-3}	10^{-4}
SNR	35.5	37.2	17.3	19	28.4	30.6	11	12.5

Figure 5: BER performance of DWT-COFDM in AWGN channel model.
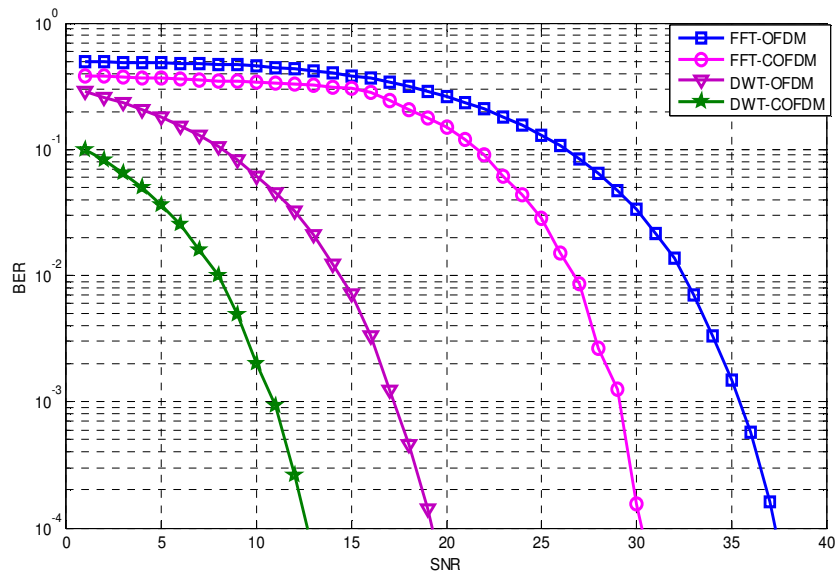
5.2. BER Performance of DWT-COFDM in Flat Fading Channel.

In this type of channel, the signal will be affected by the flat fading with addition to AWGN, in this case all the frequency components in the signal will be affected by a constant attenuation and linear phase distortion of the channel, which has been chosen to have a Rayleigh's distribution. A Doppler frequency of 4 Hz is used in this simulation. As shown in figure (6) it is found that the DWT-COFDM system outperforms significantly the three systems for this channel model.

Table 3: BER comparison of FFT-OFDM, DWT-OFDM, FFT-COFDM and DWT-COFDM in Flat Fading channel at Doppler frequency 4Hz.

	FFT-OFDM		**DWT-OFDM**		**FFT-COFDM**		**DWT-COFDM**	
BER	10^{-3}	10^{-4}	10^{-3}	10^{-4}	10^{-3}	10^{-4}	10^{-3}	10^{-4}
SNR	38	40.4	24	26.6	32	---	20	21.5

Figure 6: BER performance of DWT-COFDM in Flat Fading Channel at Doppler frequency 4Hz.
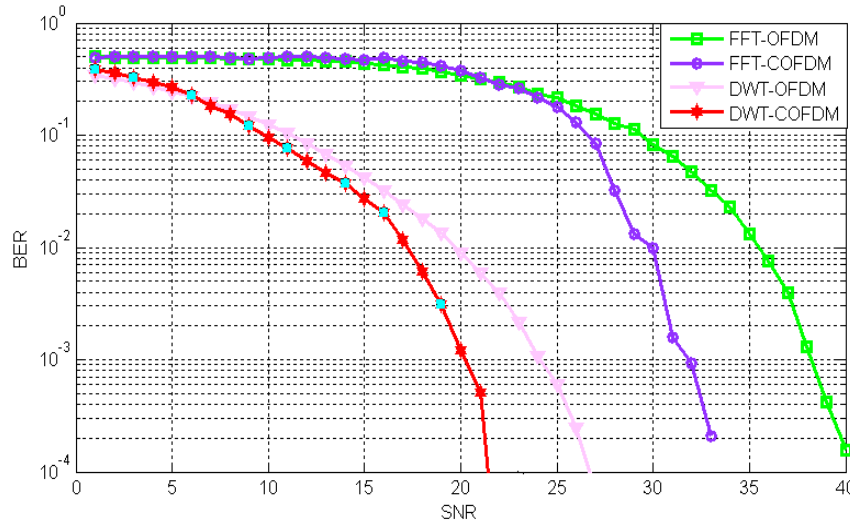
An alternative Doppler Shift is used, the value taken here is 80Hz, and the BER performance vs. SNR is shown in figure (7).

Table 4:   BER comparison of FFT-OFDM, DWT-OFDM, FFT-COFDM and DWT-COFDM in Flat Fading channel at Doppler frequency 80Hz.

	FFT-OFDM		**DWT-OFDM**		**FFT-COFDM**		**DWT-COFDM**	
BER	10^{-3}	10^{-4}	10^{-3}	10^{-4}	10^{-3}	10^{-4}	10^{-3}	10^{-4}
SNR	40	---	20.2	22.4	37	39.5	13.7	17

Figure 7: BER performance of DWT -COFDM in Flat Fading Channel at Doppler frequency 80 Hz.
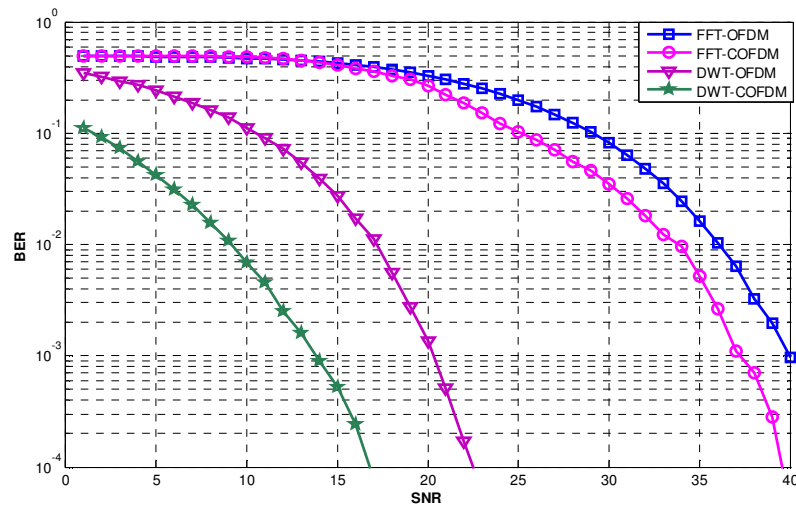
5.3. BER Performance of DWT-COFDM in Selective Fading Channel.

In this section, the channel model is assumed to be selective fading channel, where the parameters of the channel in this case corresponding to multipath where two paths are chosen. The first path is the LOS path which has average path gain equal to 0dB and a path delay of 0, and the second path has average path gain of -12dB and a path delay of 0.1 µsec. It is clearly shown from figure (7) that the BER performance of DWT-COFDM system in this channel model is also better than the three other

systems which are FFT-OFDM, FFT-COFDM and DWT-OFDM. Doppler frequencies of 4HZ and 80HZ are used in figures (8) and (9) respectively.

Figure 8: BER performance of DWT-COFDM in Selective Fading Channel at Doppler frequency 4Hz.
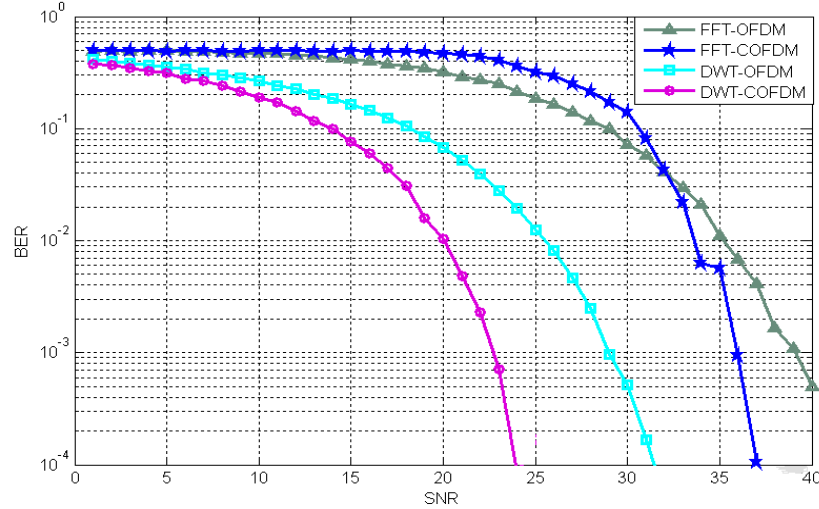
Figure 9: BER performance of DWT-COFDM in Selective Fading Channel at Doppler frequency 80Hz.
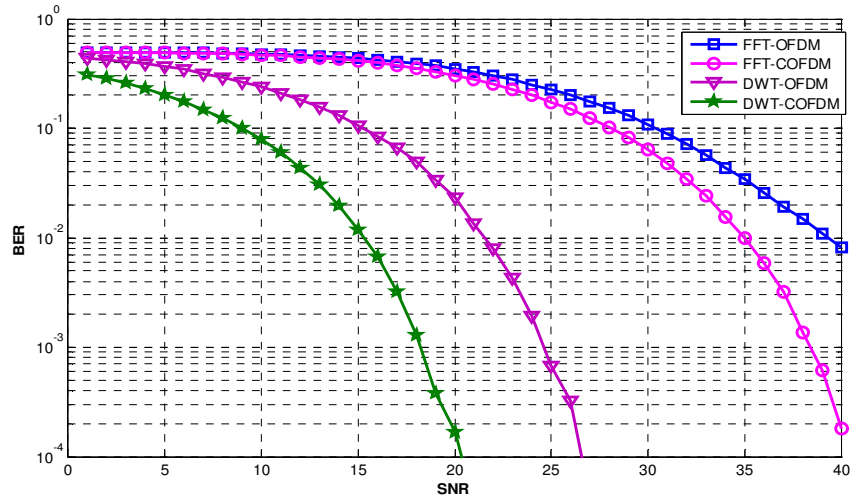
6. Conclusion

This paper compares the performance of DWT-COFDM system with FFT-OFDM, FFT-COFDM and DWT-OFDM systems in terms of bit error rate probability for different channel models which is AWGN, Flat Fading and Selective Fading channels.

From the performed simulation in the AWGN channel, it was found that the DWT-COFDM system had better performance than the three other systems. It was also found that DWT-COFDM system outperformed FFT-OFDM, FFT-COFDM and DWT-OFDM systems in the other types of channels. It was also taken two Doppler frequencies (4HZ and 80HZ) in the simulation of flat fading and selective fading channels and it was found from the simulation that the bit error rate probability increased as the value of Doppler frequency increased.

References

[1]   Kattoush A., "A Novel Radon-Wavelet Based OFDM System Design and Performance under Different Channel Conditions", International Arab Journal of Information Technology, Vol. 7, No. 4, 2010.

[2]   Al-Thahab O. Q. J. "A Multi Carrier-Code Division Multiple Access System Using Multiwavelet and Radon Transforms", Ph.D. Thsis, University of Technology, 2006.

[3]   Dilmirghani R., Ghavami M., "Wavelet vs. Fourier Based UWB Systems", 18th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, pp.1-5, 2007.

[4]   Bibiana X. A., "Design of an OFDM-DQPSK Simulation Model", M.Sc. Thesis, Technische Universiteit Eindhoven, 2003

[5]   Samuel J., Emmanuel A., Frank I., Charles N. and Bayonle A., "Modeling of Orthogonal Frequency Division Multiplexing (OFDM) for Transmission in Broadband Wireless Communications", Journal of Emerging Trends in Computing and Information Sciences, Vol. 3, No. 4, 2012.

[6]   Hill G., "Peak Power Reduction in Orthogonal Frequency Division Multiplexing Transmitters", Ph.D. Thesis, Victoria University of Technology, 2011.

[7]   Gutiérrez F. M., "Implementation of a Tx/Rx OFDM System in a FPGA", M.Sc. Thesis, University Politecnica De Catalunya, 2009.

[8]   Parvez M. Z., "Peak to Average Power Ratio (Papr) Reduction in OFDM Based Radio Systems", M.Sc. Thesis, Blekinge Institute of Technology, 2010.

[9]   Sharma S. and Kumar S., "BER Performance Evaluation of FFT-OFDM and DWT-OFDM",- International Journal of Network and Mobile Technologies, Vol. 2, ISSUE 2, 2011.

[10]   Kataria J., Kumar P. And Raj T., "A Study and Survey of OFDM versus COFDM", International Journal of Science and Modern Engineering (IJISME), Volume-1, Issue-5, 2013.

[11]   Sharma V., Shrivastav A., Jain A. and Panday A., "BER performance of OFDM-BPSK, -QPSK, -QAM over AWGN channel using forward Error correcting code", International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 3, pp.1619-1624, 2012.

Analyse Fréquentielle des Séries de Pluies et Débits Maximaux de L'ouémé et Estimation des Débits de Pointe

Avahounlin Ringo. F
LHA: Laboratoire d'Hydrologie Appliquée, Faculté des Sciences et Techniques (FAST)
Université d'Abomey Calavi (UAC), BP: 526 Cotonou,
Bénin CIPMA: Chaire Internationale en Physique Mathématique et Applications
(CIPMA-CHAIRE UNESCO), 072 BP: 50 Cotonou, Bénin
E-mail: allouboss@gmail.com

Lawin Agnidé Emmanuel
LHA: Laboratoire d'Hydrologie Appliquée, Faculté des Sciences et Techniques (FAST)
Université d'Abomey Calavi (UAC), BP: 526 Cotonou, Bénin
CIPMA: Chaire Internationale en Physique Mathématique et Applications
(CIPMA-CHAIRE UNESCO), 072 BP: 50 Cotonou, Bénin

Alamou Eric
LHA: Laboratoire d'Hydrologie Appliquée, Faculté des Sciences et Techniques (FAST)
Université d'Abomey Calavi (UAC), BP: 526 Cotonou, Bénin
CIPMA: Chaire Internationale en Physique Mathématique et Applications
(CIPMA-CHAIRE UNESCO), 072 BP: 50 Cotonou, Bénin

Chabi Amédée
CIPMA: Chaire Internationale en Physique Mathématique et Applications
(CIPMA-CHAIRE UNESCO), 072 BP: 50 Cotonou, Bénin

Afouda Abel
LHA: Laboratoire d'Hydrologie Appliquée, Faculté des Sciences et Techniques (FAST)
Université d'Abomey Calavi (UAC), BP: 526 Cotonou, Bénin
CIPMA: Chaire Internationale en Physique Mathématique et Applications
(CIPMA-CHAIRE UNESCO), 072 BP: 50 Cotonou, Bénin

Résumé

L'objectif de ce travail consiste à étudier à l'échelle du bassin de l'Ouémé (situé entre les latitudes 7°58N et 10°12N et les longitudes 1°35E et 3°05E avec une superficie de 46.920 Km^2 à l'exutoire de Bonou) les débits de pointe et les précipitations maximales annuelles en vue d'une estimation des quantiles hydropluviométriques. Premièrement, à partir des chroniques de données hydropluviométriques, des séries de précipitations maximales journalières P_{max} et des débits de pointe Q_{max} ont été générés et une analyse fréquentielle a été faite. A ces séries sont ajustées différentes lois de probabilité de valeurs extrêmes (loi logNormale 3, loi log Pearson type 3, et loi Gumbel). Les quantiles relatifs à chaque série ont été analysés ainsi que leur distribution spatiale. Par ailleurs, il est dégagé, à partir de la corrélation entre la superficie des sous bassins et les quantiles hydrologiques observés, une relation de type puissance qui permet d'estimer les débits de pointe à l'échelle du bassin de l'Ouémé. Les valeurs des critères de performance entre les débits

estimés et les observations ont permit de confirmer la formulation mathématique permettant d'estimer les débits de pointe et de conclure que les résultats obtenus servent d'indicateur pour la détermination des quantiles hydrologiques maximaux indispensables pour le dimensionnement des ouvrages hydrauliques et la localisation des zones à risques hydrologiques à l'échelle du bassin de l'Ouémé.

Motsclés: Précipitations maximales, débit de pointe, bassin de l'Ouémé, quantiles hydrologiques, analyse fréquentielle.

Abstract

This research aims to study at the Oueme river basin scale (area of 46,920 km^2, situated between 7°58N to10°12N latitude and 1°35E to 3°05E longitude), the annual flow and rainfall peaks for quantile estimation. From hydrological data, the set of the maximum daily rainfall and flow peaks are generated and their frequencies are analyzed. Different probability distributions of extreme values (logNormal type 3, log Person type 3 and Gumbel) are adjusted to these sets and their quantiles and spatial distributions are also analyzed. . Furthermore, the relationship between sub basins surface and observed hydrological quantiles is founded to be power function and realistic for flow peaks estimation at the Ouémé river basin scale. The performance criteria values confirm the objectivity of the mathematical formulation of the flow peak variation. Therefore, the results of this study can be used in hydraulic structures dimensioning and hydrological risk area determining on the Ouémé river basin.

Keywords: Maximal daily rainfall, peak flow, Ouémé basin, hydrological quantile, frequency analysis

1. Introduction

Les conséquences potentielles des changements climatiques sont, entre autres, des accroissements d'événements ou de situations hydrométéorologiques qui, jusqu'à maintenant, se présentent par de fortes précipitations ou des périodes de sécheresse prolongée. La variation globale de la pluviosité, l'excès et sa mauvaise répartition temporelle ou spatio-temporelle sur plusieurs années a eu des répercussions importantes, au plan hydrologique et agronomique, mais aussi économique, social, voire politique (Boko, 1988). L'une des conséquences les plus préjudiciables à l'économie est la non-validité des normes hydrologiques devant permettre le dimensionnement des ouvrages. Il est donc nécessaire de rechercher une méthode permettant d'analyser les maxima hydropluviométriques afin de disposer d'outils de gestion fiable. En effet la gestion rationnelle des ressources en eau à l'échelle des bassins en général et des écosystèmes en particulier nécessite une bonne connaissance de la variabilité des régimes hydrologiques surtout en période de crise liée aux évènements de crue ou d'étiage (Sourisseau and Galéa, 1996). Dans les régions tropicales sèches d'Afrique de l'Ouest, la mise en valeur des ressources en eau pour l'agriculture et l'élevage par le biais des petits aménagements hydro-agricoles, requiert une bonne connaissance des régimes hydrologiques et en particulier les caractéristiques des crues exceptionnelles pour prévenir les risques de destruction des aménagements hydrauliques et des récoltes. Par ailleurs, une bonne connaissance des régimes hydrologiques permet de mieux estimer les apports volumétriques annuels pour mieux dimensionner les ouvrages de stockage et déterminer leur potentiels à contribuer au développement et à la satisfaction des besoins des populations (Alamou, 2011).

Partant du principe selon lequel l'on gère un risque d'autant mieux que l'on s'y est préparé, il est nécessaire pour prévenir toute situation de crise, de chercher à mieux comprendre et à quantifier les régimes hydrologiques des petits bassins versants ; ce qui permet de disposer d'une meilleure estimation des paramètres hydrologiques de ces bassins et de ceux non encore jaugés ou ne possédant pas de données hydrologiques suffisantes. C'est pourquoi dans l'optique d'aider les gestionnaires des bassins au Bénin à disposer d'une meilleure connaissance des extrêmes hydrologiques à l'échelle de l'Ouémé, ce travail se propose de faire une analyse fréquentielle des débits de pointe et des précipitations maximales, d'évaluer les relations entre quantiles hydrologiques maximaux et les caractéristiques physiographiques des bassins et, enfin, de formuler un modèle permettant l'estimation des débits de pointe.

2. Données et Méthodes
2-1. Cadre D'étude et Données

Le bassin de l'Ouémé (figure 1) couvre une superficie de 46.920 km^2 à la station hydrométrique de Bonou, pour une longueur de 523 km (Le barbé et al., 1993) et s'étend entre les latitudes 7°58N et 10°12N et les longitudes 1°35E et 3°05E (Totin et al., 2007).

Le régime pluviométrique, principalement contrôlé par la circulation atmosphérique de deux masses d'air et par leurs mouvements saisonniers (l'harmattan et la mousson), se caractérise par trois types de climat du bimodal au sud à l'unimodal dans la partie nord en passant par une phase de transition au centre (Le Barbé et al., 1993). Les moyennes annuelles de précipitation (1960 – 2010) sont de 1204,77 mm au poste pluviométrique de Bétérou et de 1098,40 mm à celui de Savè.

A l'échelle du bassin, les eaux souterraines constituent la principale source d'approvisionnement en eau de la population. Le renouvellement de cette ressource dépend directement de l'infiltration efficace des précipitations, qui elle, résulte évidemment des précipitations totales, mais aussi de leur intensité, leur durée, et leur répartition dans le temps et dans l'espace. La zone considérée pour cette étude est surtout dominée par le socle cristallin et ne favorise pas l'alimentation des populations à partir des ressources en eau souterraines. D'où l'importance de l'étude des débits du cours d'eau indispensable pour la connaissance de la disponibilité en ressources en eau superficielles.

Les données utilisées dans le cadre de la présente étude concernent les séries de débits et précipitations (au pas de temps journaliers). Ces séries sont issues des bases de données du Service d'Hydrologie de la Direction Générale de l'Eau au Bénin (DG Eau) et de l'Observatoire Hydrométéorologique de la Haute Vallée de l'Ouémé (OHHVO) pour ce qui concerne les débits puis de la Direction Nationale de la Météorologie du Bénin (DNM) pour ce qui concerne les précipitations. Au total 18 postes pluviométriques et 23 stations hydrométriques ont été considérés sur la période de 1960 à 2010.

Figure 1: Bassin de l'Ouémé et points de prélèvement des données
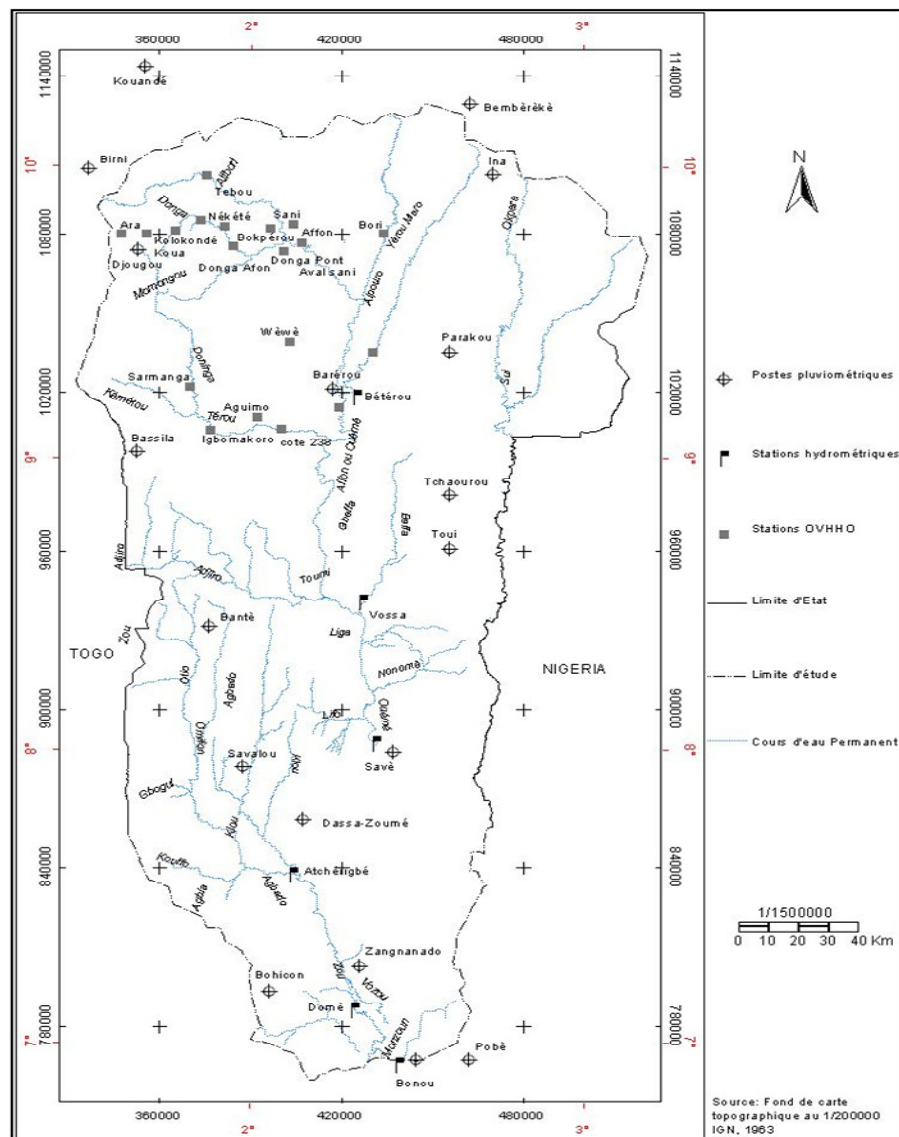
2.2. Méthode D'analyse

La disponibilité de bonnes estimations d'évènements hydrologiques extrêmes (telles que les crues et les étiages) est indispensable pour bien accomplir différentes activités d'ingénierie telle que la conception des structures hydrauliques, la gestion de la qualité de l'eau et de l'habitat ou la prévention des inondations. Pour améliorer ces estimations, de nombreuses méthodologies ont été développées durant ces dernières années (Gréhys, 1996a). Chokmani et Ouarda (2004) ont proposé une approche connue sous le nom de « krigeage canonique ». Celle-ci consiste à interpoler les quantiles de crues à l'intérieur d'un espace mathématique construit à l'aide des caractéristiques physiographiques et météorologiques des bassins versants des sites jaugés. De là, ils ont montré que cette méthode est aussi performante que les techniques conventionnelles d'estimation régionale les plus établies, telles que l'analyse canonique des corrélations (Ouarda et al., 2001). Gréhys (1996b, 1996c), dans une étude comparative a montré qu'au niveau de l'estimation régionale, la méthode de l'indice de crue (Darlymple, 1960) et les méthodes d'analyse dés régressions (Nguyen et Pandey, 1996; Ouarda et al, 2006) sont pratiquement équivalentes et conduisent à des estimations meilleures aux autres méthodes. Aux côtés de toutes ces méthodes, l'analyse fréquentielle reconnue comme étant une méthode

statistique de prédiction consistant à étudier les événements passés, caractéristiques d'un processus donné afin d'en définir les probabilités d'apparition future (Musy, 2003), est la méthode la mieux utilisée en hydrométéorologie pour estimer les extrêmes hydropluviométriques. Elle permet d'obtenir des estimations quand l'information hydrologique est disponible au site d'intérêt et est de bonne qualité. Dans le cadre de la présente étude, l'analyse fréquentielle a été appliquée aux séries chronologiques des débits (m³/s) et des pluies (mm).

A partir des échantillons constitués, on choisit la forme mathématique de la loi de probabilité et on calcule le mieux possible les paramètres numériques de la loi. L'ajustement statistique est réalisé par l'intermédiaire du logiciel HYFRAN (HYdrological FRequency ANalysis) de la chaire industrielle en hydrologie statistique de l'INRS-ETE. Les différentes étapes de l'ajustement de loi à un échantillon effectuées par le logiciel HYFRAN sont brièvement présentées ci-après.

Vérification des Hypothèses

L'ajustement d'une distribution à un échantillon nécessite que les observations soient indépendantes (l'indépendance signifie qu'il n'y a aucun lien entre les observations successives (absence d'auto-corrélation), identiquement distribuées ou homogènes (l'homogénéité des valeurs des observations permet d'émettre l'hypothèse qu'elles sont toutes issues de la même population) et stationnaires (la distribution des échantillons est dite stationnaire si les caractéristiques statistiques sont invariantes dans le temps et dans l'espace. La non stationnarité est en particulier caractérisée par un changement brusque ou graduel dans la moyenne).

Distribution et Méthodes D'ajustement

Dans le cadre de l'ajustement statistique des différentes séries, les lois les plus appropriées ont été choisies a priori. Différentes méthodes existent pour ajuster les distributions statistiques aux échantillons. Dans la littérature les auteurs proposent, plusieurs lois comme fonction de distribution des valeurs extrêmes et appliquées aux séries chronologiques. On peut citer la loi Gumbel, les lois normales, la loi exponentielle, les lois Gamma, la loi GEV, les lois Pearson. Ces différentes lois font partie du domaine d'attraction de la loi GEV (Alamou, 2011), d'où la nécessité de mieux en préciser les relations. Nous avons ici testé pour chacune des séries constituées, les lois Gumbel, logNormale et Pearson dont les distributions sont respectivement représentées par les équations 1, 2 et 3 ci-après :

$$f(x) = \frac{1}{\alpha} \exp\left[-\frac{x-m}{\alpha} * \exp\left(\frac{x-m}{\alpha} \right) \right] \qquad \text{(Eq. 1)}$$

$$f(x) = \frac{1}{(x-m)\beta\sqrt{2\pi}} * \exp\left[-\frac{[\ln(x-m)-\alpha]^2}{2\beta^2} \right] \qquad \text{(Eq. 2)}$$

$$f(x) = \frac{1}{\Gamma(\beta)} \left(\frac{x-m}{\alpha} \right)^{\beta-1} * \exp\left[-\left(\frac{x-m}{\alpha} \right) \right] \qquad \text{(Eq. 3)}$$

avec, m : paramètre de position (mode)

α : paramètre d'échelle positif différent de zéro

β **:** paramètre de forme positif différent de zéro

et, $\Gamma(\beta): \sum\limits_{0}^{\infty} \left[\left(\frac{x-m}{\alpha} \right)^{\beta-1} * e^{\left(\frac{x-m}{\alpha} \right)} \right]$: fonction Gamma complète

Les principales méthodes d'estimation des paramètres de lois statistiques ont été utilisées pour estimer les paramètres des différentes lois de probabilité. Il s'agit de la méthode des moments puis du maximum de vraisemblance. La méthode des moments consiste à égaler les moments théoriques de la distribution (qui sont fonction des paramètres) et leurs estimations obtenues à partir de l'échantillon. La résolution du système d'équations qui en résulte permet ensuite d'obtenir les différents paramètres

de la loi. La méthode du maximum de vraisemblance fait intervenir une fonction de vraisemblance L définie par :

$$L = \prod_{1}^{N} f\left(x_i; \theta_1, \ldots \ldots \theta_k\right)$$

$$f\left(x_i\right) dx_i = P\left[x_i \subseteq X \subseteq x_i + dx_i\right]$$

(Eq 4)

Elle consiste ensuite à trouver les paramètres θqui maximisent la fonction de vraisemblance, soit la probabilité d'observer l'échantillon (*x$_i$,…….x$_N$)* qui représente la meilleure information disponible sur la population. Pour l'ajustement statistique, la méthode des moments est associée à la loi de Gumbel, tandis que la méthode du maximum de vraisemblance est appliquée aux lois de Pearson type III, et la loi LogNormale.

Une fois les ajustements effectués, l'observation des courbes d'ajustement montre que celles qui s'étendent vers l'extrémité s'ajustent mieux comparativement aux autres. Toutefois les ajustements ont ensuite été contrôlés a posteriori afin d'écarter tout ajustement peu adapté à la série d'observations. Ce contrôle est effectué au moyen des critères de parcimonie AIC et BIC (Eq.5) définis par :

$$AIC = -2\log\left(L\right) + 2K$$

$$BIC = -2\log\left(L\right) + 2K\log\left(N\right)$$

(Eq 5)

Avec, L : la vraisemblance ;
K : le nombre de paramètres de la loi ;
N : la taille de l'échantillon.

Il faut signaler que ces critères permettent de retenir la loi pour laquelle leurs valeurs restent la plus petite pour une probabilité à postériori plus élevée.

2-3. Interpolation Spatiale des Quantiles Hydropluviométriques

L'interpolation spatiale des quantiles a été faite par la méthode du krigeage ordinaire (Matheron, 1965, 1971; Cressie, 1993) qui suppose la moyenne du processus inconnue. Les bases de la méthode reposent sur le calcul et la modélisation de la fonction de structure spatiale (γ) ou variogramme du processus.

- **Calcul du variogramme**

Soit un processus bidimensionnel représenté par une fonction aléatoire (F.A.) ϕ prenant la valeur $\phi(x)$ au point x puis la valeur $\phi(x+h)$ en un point situé à la distance h du point x. Le variogramme γ est alors calculé par l'éq.6 qui exprime que le variogramme est l'accroissement quadratique moyen entre deux points séparés d'une distance h.

$$\gamma(h) = \frac{1}{2} E\left[\left(\varphi(x+h) - \varphi(x)\right)^2\right]$$

(Eq. 6)

En hydrométéorologie, dans la pratique, compte tenu du nombre limité de points de mesures (stations), le calcul du variogramme (variogramme expérimental (γ_e)) se fait (Eq. 7) par la moyenne quadratique empirique sur l'ensemble de tous les points distants approximativement de h, formant la classe h.

$$\gamma_e(h) = \frac{1}{2N_h} \sum_{i=1}^{N_h} \left[\left(\varphi(x+h) - \varphi(x)\right)^2\right]$$

(Eq. 7)

Où N_h représente le nombre de couples de stations (i, j) telles que la distance les séparant est donnée par:

$$h_{ij} = \|x_i - x_j\| \in \left[h \pm \frac{\Delta h}{2}\right]$$

(Eq. 8)

Avec Δh le pas de découpage des classes.

Chaque classe a été représentée par son centre et un modèle de variogramme est ajusté au variogramme brute par la méthode automatique des moindres carrés.

- **Interpolation des données**

L'interpolation est faite en utilisant le variogramme modélisé. Des points de grille régulière ont été considérés. L'estimation des valeurs est faite de la façon suivante :

Soit un point x_0 où la F.A. ϕ a la valeur $\phi(x_0)$ inconnue. La valeur inconnue est estimée par $\varphi^*(x_0)$ comme une somme pondérée des valeurs observées ou mesurées (Eq. 9) aux N_S points choisis (voisinage) du réseau d'observation par :

$$\phi^*(x_0) = \sum_{j=1}^{N_S} \lambda_j \phi(x_j) \tag{Eq. 9}$$

Où λ_j représente le poids de pondération de la valeur observée au point x_j.

Les poids de pondération λ_j sont déterminés en résolvant le système de krigeage (Eq. 10) qui découle des conditions d'optimalité et de non biais du krigeage (Matheron, 1971).

$$\sum_{j=1}^{N_S} \lambda_j \gamma(h_{ij}) + \mu = \gamma(h_{0i}) \quad ; \quad i = 1, 2, 3, \ldots, N_S \tag{Eq. 10}$$

$$\sum_{j=1}^{N_S} \lambda_j = 1$$

Où μ est le multiplicateur de Lagrange. Dans ce travail, nous avons adopté le voisinage global pour l'interpolation. Une fois les poids de pondération déterminés on déduit les valeurs estimées par krigeage.

3. Résultats et Discussions
3-1. Analyse Fréquentielle des Précipitations et Débits de Pointe

A partir des séries chronologiques de données hydropluviométriques, les maxima journaliers de chaque année de la période Pj_{max} et Qj_{max} ont été constitués. Les statistiques descriptives de ces séries sont consignées dans le tableau 1.

Tableau 1: Statistiques descriptives des séries constituées

	Postes pluviométriques					
	min	max	moy	Ecart-type	Médiane	Cv
Kouandé	11,5	172	82,1	27,5	81,3	0,334
Birni	17,1	144	73,2	26,4	76,8	0,36
Djougou	21,2	147	77,9	20,6	75,5	0,264
Bembèrèkè	42	141	76,6	19,2	76,1	0,25
Ina	29,4	147	71,9	20,6	71,5	0,287
Parakou	44,8	176	87	28,9	81,3	0,332
Bétérou	35,5	144	78	19,9	76,9	0,256
Bassila	40,9	129	73,5	19,2	73	0,261
Tchaourou	28,9	155	73	24,2	76,2	0,332
Toui	43,4	130	75,7	21,8	72,3	0,287
Bantè	36,3	162	81,5	24,7	75,5	0,304
Savalou	27,4	177	87,8	32,3	81,1	0,367
Savè	45,1	184	81,5	27,7	78,1	0,34
Dassa	30,4	177	87,5	28,8	81,6	0,329
Bohicon	38,8	129	81,2	20,9	83,5	0,258
Zangnanado	48,2	131	78,2	20,4	73	0,261

Tableau 1: Statistiques descriptives des séries constituées - continued

Pobè	49,2	138	83,2	25,3	80,9	0,304
Bonou	38,6	153	76,1	23,6	68,7	0,311
Ouémé à Bétérou	38,2	776	382	173	408	0,452
Beffa à Vossa	0,535	210	81,3	58,9	83	0,725
Ouémé à Savè	74,2	1730	859	380	877	0,442
Zou à Atchérigbé	43,6	872	351	204	315	0,583
Zou à Domè	4,5	172	107	41,1	122	0,383
Ouémé à Bonou	109	1400	810	297	922	0,367

Pour vérifier le caractère stationnaire, d'indépendance et d'homogénéité des séries considérées, les tests de stationnarité de Kendall (Kendal et al, 1943; Aka *et al.,* Dao A., 2007) d'indépendance de Wald-Wolfowitz (Hache *et al.,* 1999) et d'homogénéité de Wilcoxon (Siegel, 1956) ont été appliqués. Les résultats de ces tests (Tableau 2) montrent que les différentes séries constituées sont indépendantes, homogènes et stationnaires.

Tableau 2: Valeurs des paramètres statistiques

Postes pluviométriques	Test d'Indépendance		Test de Stationnarité		Test d'Homogénéité	
	U	P	K	P	W	P
Kouandé	2,07	0,0385	1, 37	0,172	1,97	0,0483
Birni	0,172	0,863	1,49	0,135	0,396	0,692
Djougou	0,294	0,769	0,233	0,816	0,28	0,779
Bembèrèkè	0,999	0,318	0,544	0,587	0,0388	0,969
Ina	0,955	0,339	1,98	0,0475	0,824	0,41
Parakou	1,01	0,313	1,19	0,235	1,87	0,061
Bétérou	1,43	0,152	1,29	0,198	1,56	0,118
Bassila	0,213	0,831	1,22	0,222	0,626	0,532
Tchaourou	0,479	0,632	0,331	0,74	0,22	0,826
Toui	1,17	0,244	0,443	0,658	0,379	0,705
Bantè	2,43	0,0152	0,715	0,474	0,2	0,841
Savalou	0,269	0,788	0,448	0,654	0,411	0,681
Savè	0,174	0,862	0,0753	0,94	0,379	0,705
Dassa	0,223	0,823	0,202	0,84	0,514	0,608
Bohicon	0,788	0,431	0,711	0,477	1,42	0,156
Zangnanado	0,494	0,621	1,56	0,12	1,46	0,145
Pobè	2,85	0,0044	0,0568	0,955	1,72	0,0859
Bonou	0, 306	0,76	0,509	0,611	0,84	0,401
Stations hydrométriques DGEau						
Ouémé à Bétérou	2,99	0,0028	0,0603	0,952	0,99	0,322
Beffa à Vossa	0,451	0,652	2,24	0,0252		
Ouémé à Savè	1,94	0,0522	0,055	0,956	1,14	0,254
Zou à Atchérigbé	0,412	0,681	0,303	0,762	0,287	0,774
Zou à Domè	1,9	0,0569	0,64	0,522	0,254	0,8
Ouémé à Bonou	2,41	0,0159	1,21	0,226	0,0106	0,992

Les séries ont été ensuite ajustées à différentes lois de probabilité. Les critères de parcimonie et le test de Khi^2 ont permis de valider pour chaque série une loi de probabilité. A partir de la loi de probabilité validée, les valeurs des quantiles correspondant à chaque série ont été calculées (tableau 3). Pour la plupart des séries, les périodes de retour maximales encore significatives sont comprises entre 2n et 3n, n étant le nombre d'observations (ici n = 50). Étant donné que pour les différentes stations

hydrométriques et postes pluviométriques, une série temporelle de 60 valeurs annuelles a été établie, les périodes de retour associées aux différentes lois seront donc 2, 5, 10, 20, 50 et 100 ans, 100 ans étant la limite de représentativité. De l'analyse des quantiles, on note une faible variation des valeurs observées de précipitations maximales. Les hauteurs moyennes de précipitations maximales de 97,1; 110,7 ; 123,1; 139,2 et 151,2 ont une période de retour respective de 5 ; 10 ; 20 ; 50 et 100. Quant aux quantiles de débits de pointe, ils sont fonction de l'aire drainée par le cours d'eau à l'échelle du sous bassin.

Tableau 3: Valeurs des quantiles de précipitations maximales et de débits de pointe observés

Quantiles observés Précipitations maximales (mm) de période de retour T							
Poste pluviométrique	Lois de probabilité	P_{100}	P_{50}	P_{20}	P_{10}	P_5	P_2
Kouandé	Gumbel	160	149	132	119	104	78,8
Birni	LogNormale (3p)	135	128	117	107	95,4	73,2
Djougou	LogNormale (3p)	133	125	114	105	94,5	76,3
Bembèrèkè	Gumbel	137	126	112	102	90,4	73,4
Ina	Gumbel	137	125	110	98,8	86,7	68,5
Parakou	Gumbel	178	162	141	125	108	82,3
Bétérou	LogNormale (3p)	133	125	114	104	93,9	76,2
Bassila	Gumbel	134	123	109	98,6	87,3	70,4
Tchaourou	Gumbel	149	136	118	105	90,5	69
Toui	Gumbel	144	132	116	104	91,4	72,2
Bantè	Gumbel	159	146	128	114	99,3	77,4
Savalou	Gumbel	189	171	148	130	111	82,5
Savè	Gumbel	168	153	133	118	101	77
Dassa	Gumbel	178	162	141	125	108	82,8
Bohicon	LogNormale (3p)	132	126	117	109	98,7	80,3
Zangnanado	Gumbel	142	131	116	105	92,9	74,8
Pobè	Gumbel	163	149	130	116	101	79,1
Bonou	Gumbel	150	137	120	107	93,1	72,2
Débit de pointe (m3/s) de période de retour T							
Stations hydrométriques	Lois de probabilité	Q_{100}	Q_{50}	Q_{20}	Q_{10}	Q_5	Q_2
Ouémé à Savè	Gumbel	1640	1580	1470	1350	1190	870
Ouémé à Bétérou	Gumbel	1030	918	772	659	541	364
Ouémé à Bonou	LogNormale (3p)	1690	1550	1350	1200	1040	773
Zou à Atchérigbé	LogNormale (3p)	835	793	718	640	535	327
Beffa à Vossa	Gumbel	266	234	191	158	124	71,6
Zou à Domè	Gumbel	236	214	184	161	137	101

Les répartitions spatiales des différents quantiles observés sont illustrées aux figures 2 et 3. Le tracé des courbes iso-valeurs a été obtenu de façon automatique par la méthode du krigeage. Les isohyètes obtenues varient peu à l'échelle du bassin. Toutefois de fortes valeurs sont obtenues entre les latitudes 7.5°N et 8.5°N (autour de Savè, Savalou et Dassa-Zoumé) d'une part et entre les latitudes 9.5°N et 10°N d'autre part (entre Tchaourou et Parakou). Ces zones correspondent respectivement aux régions de collines et de forêt. Les régions forestières sont le siège d'intense évapotranspiration faisant parfois objet de pluviométrie abondante. Les fortes valeurs de pluies enregistrées dans les régions de collines témoignent du rôle important de l'orographie dans les précipitations locales.

Quant aux débits de pointe, on note de très fortes variations des quantiles du Sud vers le Nord. Les lignes d'iso-valeurs presque parallèles vers le Nord se resserrent au Sud avec de forts écoulements.

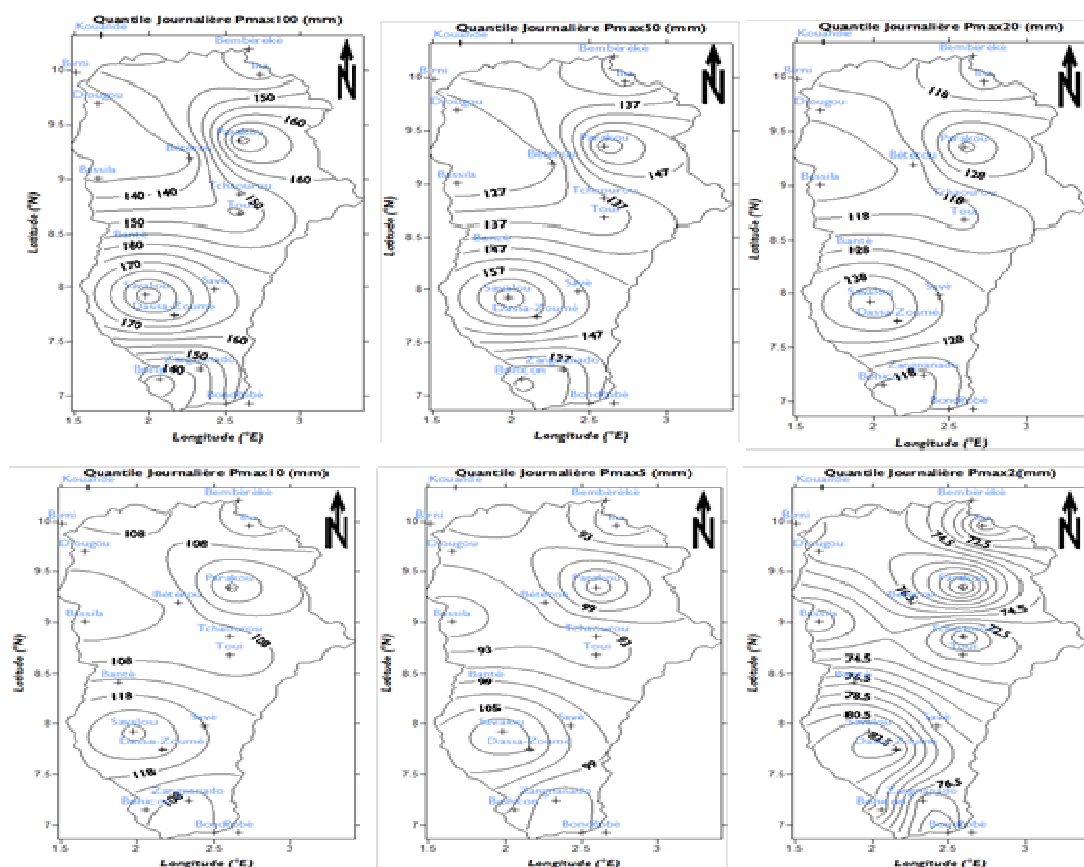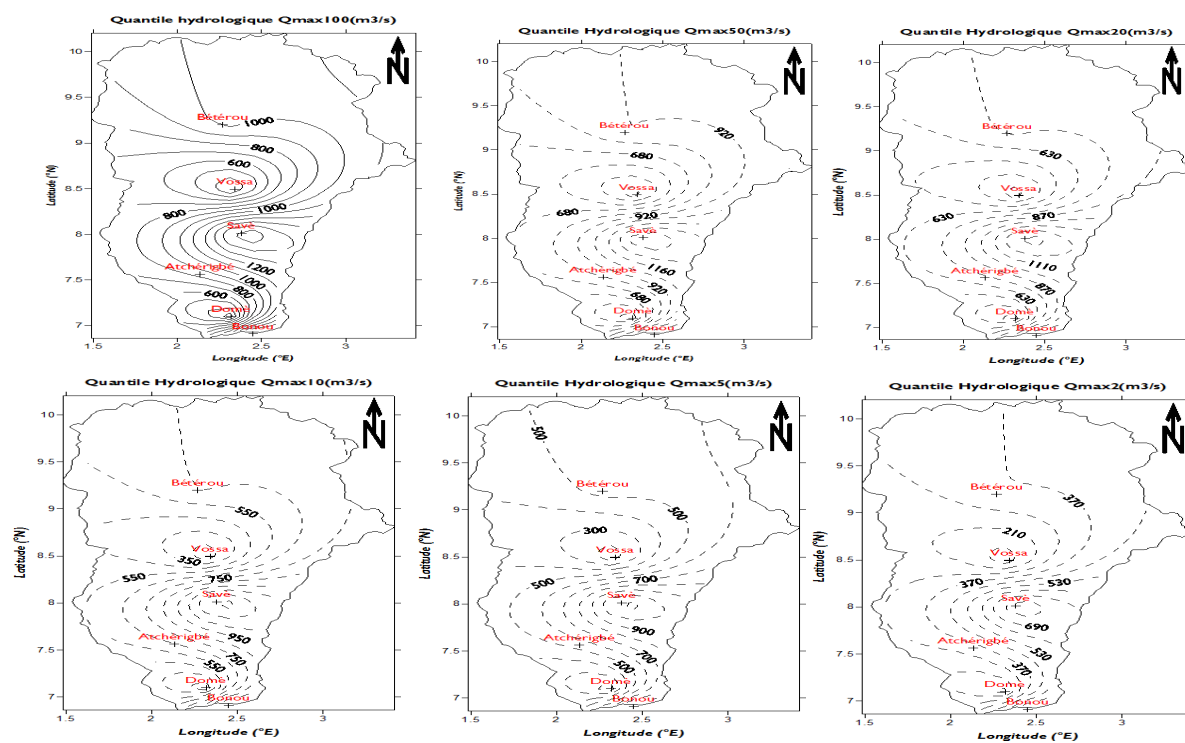**Figure 2:** Répartition spatiale des quantiles de précipitations maximales

**Figure 3:** Distribution spatiale des quantiles des débits de pointe

3.2. Estimation des Débits de Pointe

Détermination des Quantiles Hydrologiques

Afin de proposer une formulation mathématique permettant l'évaluation des quantiles hydrologiques Q_{max} à l'échelle des bassins versants non jaugés ou ne disposant pas de données suffisantes, les relations entre quantiles hydrologiques et superficies des sous bassins sont établies. Ainsi, les relations existantes entre quantiles de débit de pointe d'un sous bassin à un autre d'une part et entre ces quantiles et les superficies des sous bassins sont analysées.

De très bonnes corrélations ont été obtenues entre quantiles de débit des différents sous bassins (Figure 4). Les quantiles observés d'un sous bassin jaugé peuvent donc être utilisé pour estimer ceux des autres sous bassins non jaugés de l'Ouémé ou des bassins similaires sur lesquels l'on ne dispose pas ou très de données.

Figure 4: Corrélation entre quantiles hydrologiques des différents sous bassins
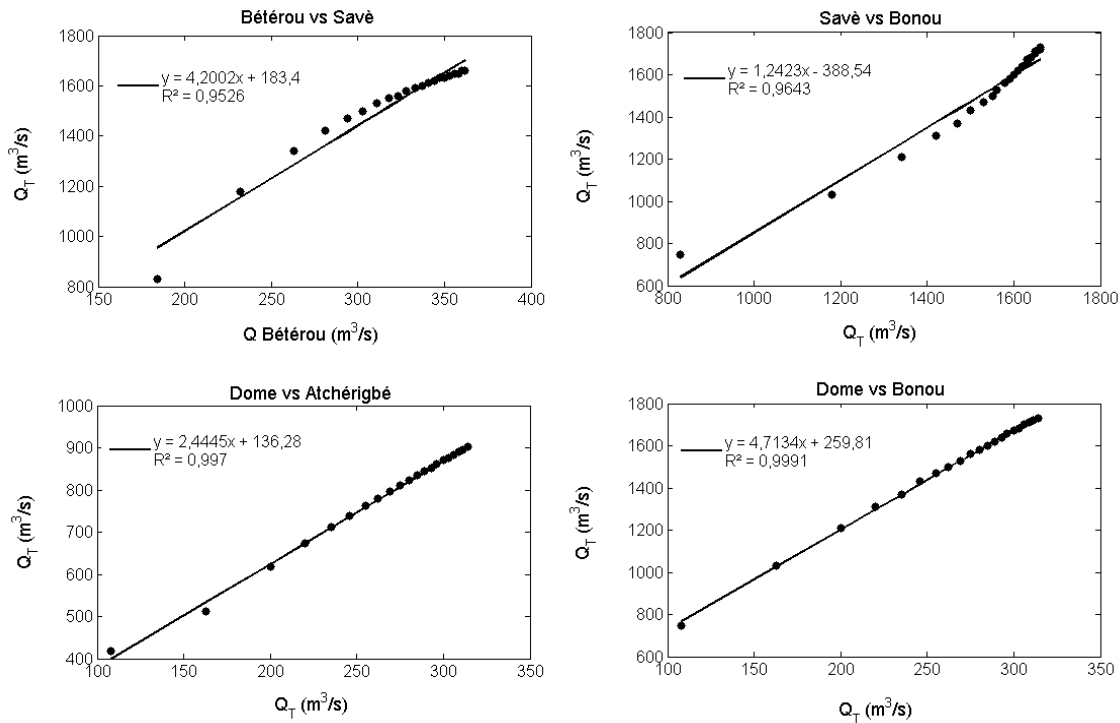
Pour une estimation des débits de pointe à l'échelle des bassins versants non jaugés ou de ceux ne disposant pas de données suffisantes, il est dégagé une relation entre quantile observé et la superficie des différents sous bassins (Figure 5). Celle-ci est de type puissance et définie par : $Q_T = kS^\alpha$,

avec, Q_T : débit de pointe de période de retour T;
S: superficie du bassin;
K: coefficient numérique fonction de la période de retour T;
α: facteur d'échelle fonction de la période de retour T.
Les différentes valeurs de K et α sont consignées dans le tableau 4.

Tableau 4: Valeurs des paramètres k et α suivant les périodes de retour T

T (ans)	100	50	20	10	5
k	3,37	2,75	2,04	1,55	1,1
α	0,6	0,62	0,63	0,65	0,67

A partir de la formulation mathématique, les quantiles Qmax à l'échelle des sous bassins de l'ouémé ont été estimés et consignés dans le tableau 5 (valeurs en gras). Les quantiles obtenus sur les sous bassins de l'Ouémé à Savè, Bétérou et Atchérigbé sont sous-estimés alors qu'ils sont sur-estimés à Vossa, Bonou et Domé. Toutefois de bonnes corrélations ont été obtenues à l'échelle des différents sous bassins. Le coefficient de détermination R^2, critère de performance calculé sur l'ensemble de la série estimée et pour tous les sous bassins confondus donne une valeur de 0,91 ; permettant de confirmer l'objectivité de la méthodologie utilisée pour quantifier les quantiles de débit à l'échelle de l'Ouémé.

Figure 5: Relation entre quantile hydrologique et superficies de sous bassins
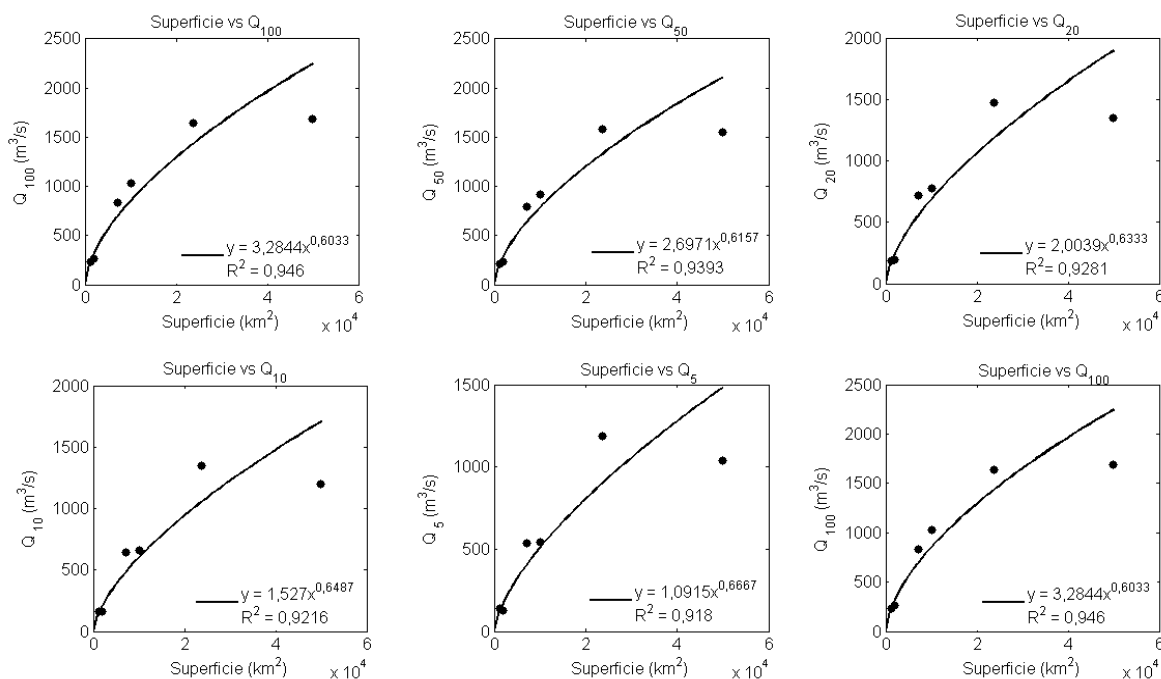
Tableau 5 : Comparaison des débits de pointe estimés aux observations

Stations	Quantiles				
	$Qmax_{100}$	$Qmax_{50}$	$Qmax_{20}$	$Qmax_{10}$	$Qmax_5$
Savè	1640	1580	1470	1350	1190
	1447,62	**1347,33**	**1196,93**	**1066,75**	**914,31**
Bétérou	1030	918	772	659	541
	798,56	**733,89**	**640,35**	**561,8**	**472,89**
Bonou	1690	1550	1350	1200	1040
	2264,44	**2127,7**	**1915,93**	**1727,84**	**1501,21**
Atchérigbé	835	793	718	640	535
	699,67	**641,21**	**557,25**	**487,195**	**408,44**
Vossa	266	234	191	158	124
	322,68	**290,89**	**246,96**	**211,54**	**173,22**
Domè	236	214	184	161	137
	252,75	**226,67**	**191,023**	**162,57**	**132,145**

Application aux Bassins sous Jaugés

Compte tenu de l'objectivité de la méthodologie utilisée pour quantifier les extrêmes hydrologiques, les valeurs des quantiles des bassins sous jaugés de l'OHHVO, bassin sur lesquels l'on ne dispose pas de données suffisantes (données sur 6 à 11 ans) sont estimées. Au total 17 sous bassins (de superficie

comprise entre 12,3 et 3283 Km^2) composent cet observatoire. Nous disposons des données de débits journaliers sur la période de 1996 à 2007. De ces dernières sont extraites des séries de débits de pointe auxquelles est ajustée la loi Gumbel. Malgré la taille réduite de la série (série inférieure à 20 ans) pour une analyse fréquentielle, les quantiles ont été calculés à titre indicatif. Les différents quantiles observés corrélés avec ceux estimés au moyen de la formulation mathématique montrent (Figure 6) de bonnes corrélations avec un coefficient de détermination égale en moyenne à 0,70.

Figure 6: Corrélation entre quantiles hydrologiques estimés et les observations
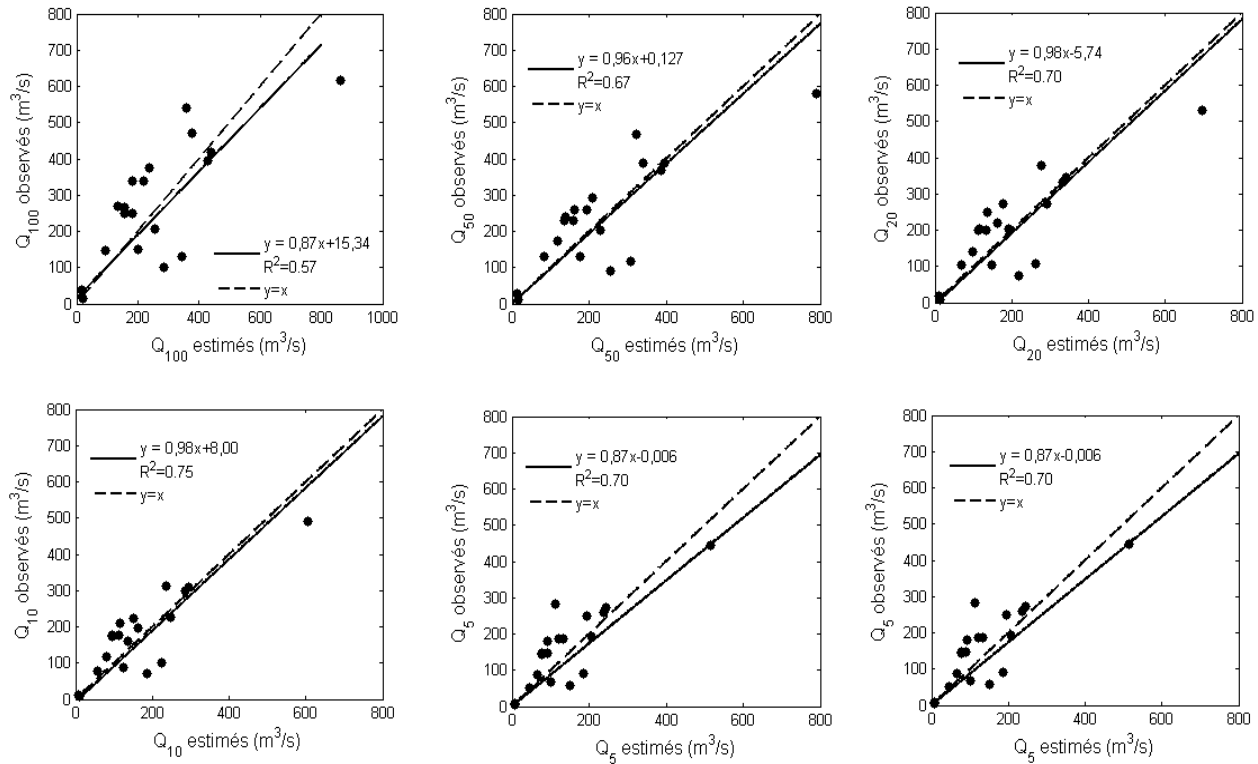
Considérant un débit de pointe (Q$_{maxj}$) comme tout débit de période de retour T, on peut écrire

$$Q_{\max j} = K_m S^{\alpha_m} \; ;$$

avec, Q$_{maxj}$: débit de pointe (m^3/s)

K$_m$: coefficient numérique fixé à 2,16

α$_m$: facteur d'échelle égal à 0,63.

De cette relation définitive sont estimés les débits de pointe qui, corrélés avec les observations (Figure 7), donnent un bon coefficient de détermination (0,78).

En plus du critère visuel d'évaluation et du coefficient de détermination, le critère de Nash-Sutcliffe habituellement utilisé en hydrologie a été sélectionné pour mesurer l'adéquation entre les valeurs estimées et les observations. La valeur de ce critère (0,76) témoigne de la qualité de l'estimation des débits de pointe et la formulation mathématique reste donc indiquée à générer à l'échelle du bassin de l'Ouémé les débits de pointe et les quantiles correspondants qui sont des paramètres très indispensables dans les travaux d'ingénierie et la localisation des zones à risques hydrologiques à l'échelle du bassin.

Figure 7: Corrélation entre débits maximaux estimés et les observations à l'échelle de l'OHHVO
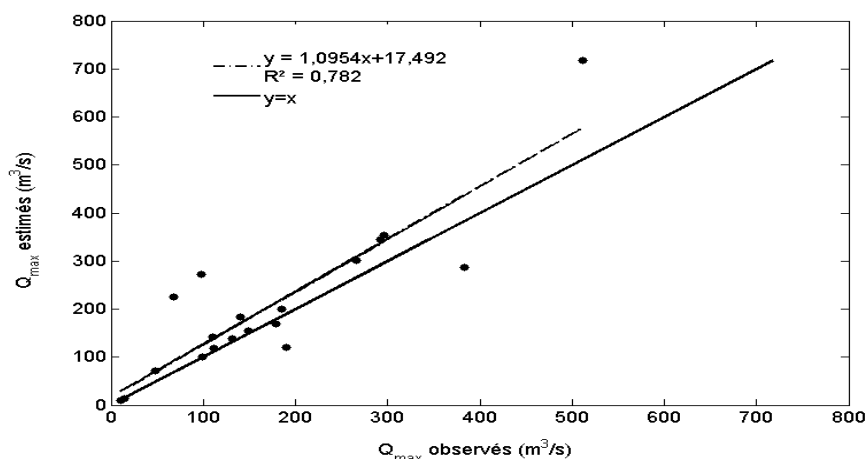
4. Conclusion

Les extrêmes hydropluviométriques en l'occurrence les débits de pointe et les précipitations maximales journalières, sont étudiées à l'échelle de l'Ouémé à Bonou. L'analyse fréquentielle des échantillons montrent qu'aux différentes séries s'ajustent plusieurs lois de probabilité caractéristiques des valeurs extrêmes.

La répartition des quantiles obtenus montre une faible variation des isohyètes. Toutefois, de fortes valeurs de pluies sont obtenues entre les latitudes 7.5°N et 8.5°N d'une part, et entre les latitudes 9.5°N et 10°N d'autre part. Ces zones sont situées dans les régions de collines et de forêt, sièges d'intense évapotranspiration synonyme de pluviométrie abondante et sous influence de l'orographie. Quant aux quantiles hydrologiques, l'observation des iso-valeurs montre de très fortes variations du Sud vers le Nord où les courbes d'iso-valeurs presque parallèles vers le Nord se resserrent au Sud avec de forts écoulements traduisant une descente des eaux vers la partie méridionale souvent sujette à des inondations.

L'analyse des relations entre quantiles hydrologiques et les superficies des sous bassins montre de fortes corrélations. Il s'en dégage alors une formulation de type $Q_T = KS^\alpha$ où K (un coefficient numérique) et α (facteur d'échelle) sont des paramètres fonction de la période de retour. A partir de cette formulation les débits de pointe de période de retour T à l'échelle des sous bassins de l'Ouémé ont été estimés. Le coefficient de détermination R^2 obtenu (0.91) sur l'ensemble de la série estimée permet de confirmer l'objectivité de la méthodologie adoptée pour quantifier les quantiles de débit à l'échelle du bassin de l'Ouémé. Ce qui a permis d'estimer les quantiles hydrologiques correspondant aux sous bassins de l'OHHVO. Considérant tout débit comme un débit de période de retour T, les différents débits de pointe de ces sous bassins ont été générés par application de la formule mathématique identifiée $Q_{\max j} = K_m S^{\alpha_m}$ où K_m = 2,16 et α_m = 0,63. L'analyse de la corrélation entre les valeurs générées et celles observées montrent un coefficient de corrélation de l'ordre de 0,78, et un coefficient de Nash de 0,76 ; valeurs significatives permettant de conclure que les résultats obtenus servent d'indicateur pour la détermination des quantiles hydrologiques maximaux indispensables pour le dimensionnement des ouvrages hydrauliques et la localisation des zones à risque hydrologique à l'échelle du bassin.

Références Bibliographiques

[1] Aka A., Servat E., Paturel J.E., Kouamé B., and Lubes H. & Masson, J.M. (1996): Analysis of the temporal variability of runoff in Ivory Coast: statistical approach and phenomena characterization, Hydrological Sciences Journal, 41(6), 959–970.

[2]   Alamou, 2011 : Application du principe de moindre action à la modélisation pluie – débit, thèse de Doctorat, CIPMA Chaire UNESCO, Université d'Abomey Calavi, Bénin, 211p + annexes.

[3]   Boko M., 1988 : Climats et communautés rurales du Bénin. Rythmes climatiques et rythmes de développement. Thèse de Doctorat, Université de Bourgogne, Dijon, 2 tomes, 608p.

[4]   Chokmani, K. et Ouarda T.B.M.J., 2004: Physiographical space based kriging for regional flood frequency estimation at ungauged sites. Water Resour. Res., 40, W12514, 16p.

[5]   Cressie N. (1993). Statistics for Spatial Data. Wiley, New York, USA, 900p.

[6]   Dao Amidou (2007). Etude des pluies journalières Extrêmes de la Côte d'Ivoire, Mémoire de DEA, 62p.

[7]   Darlymple T., 1960: Flood Frequency methods U.S. Geol. Surv. Water Supply Pap., 1543A, 11-51.

[8]   GREHYS (Groupe de Recherche en Hydrologie Statistique), 1996: Presentation and review of some methods for regional flood frequency analysis. J. Hydrol. 186, 63-84.

[9]   GREHYS, 1996a (Groupe de Recherche en Hydrologie Statistique, 1996a): Presentation and review of some methods for regional flood frequency analysis. J. Hydrol., 186, 63-84.

[10]   GREHYS, 1996b (Groupe de Recherche en Hydrologie Statistique, 1996b) : Inter-comparison of regional flood frequency procedures for Canadian rivers. J. Hydrol., 186, 85-103.

[11]   Hache M., Perreault L., Remillard L. & Bobbée B., 1999: Une approche pour la sélection des distributions statistiques : application au bassin hydrographique du Saguenay Lac St Jean, Revue Canadien de Génie Civil. 26 (2), 216-225.

[12]   HYFRAN, 2003: A software for statistical modeling. INRS-Eau, University of Québec.

[13]   Le Barbé L., ALE G., Millet B., Texier., Borel Y., Gualde R. (1993) : Les ressources en eaux superficielles de la République du Bénin, édition de l'ORSTOM, Paris, France 540p.

[14]   Matheron G. (1965) Les variables régionalisées et leur estimation. Masson et Cie. Paris, France, 305p.

[15]   Matheron, G. (1971). Regionalized variables theory and its applications. Note book of mathematical morphology Centre, Fasc. 5, EMP. Paris, France, 212 p.

[16]   Musy A., 2003 : Hydrologie générale, support de cours, chapitre 3, les précipitations, 15p.

[17]   Nguyen V.T.V., Pandey G.R., 1996: A scaling approch to regional estimation of floods. Proc. Int. Conf. Wat. Ressour. Env. Res., octobre 29-31, 301- 308.

[18]   Ouarda T.B.M.J., C. Girard, G. Cavadias et B. Bobée, (2001): Regional flood frequency estimation with canonical correlation analysis. J. Hydrol., 254,157-173.

[19]   Ouarda, T.B.M.J., Cunderlik, J.M., St-Hilaire, A., Barbet, M., Bruneau, P., Bobée, B. (2006) Data-based comparison of seasonality-based regional flood frequency methods. J. Hydrol. 330, 329–339.

[20]   Siegel S. (1956): Non-parametric statistics for the behavioral sciences., New York: McGraw-Hill, J.Hydrol.83, 202-213

[21]   Sourisseau J., Galéa G. 1996 : Représentativité des modèles QdF, application à la régionalisation des régimes de crue du bassin versant de la Loire, Cemagref, groupement de Lyon- Division hydrologie hydraulique ; EPFL-IATE ; Ministère de l'Environnement- Division de l'Eau, IAHS.Publ.no.246, 1997, 277-285.

[22]   **St**-Hilaire A. 2005 : Analyse fréquentielle des précipitations des stations de Montréal et Shawinigan. Rapport de recherche R832 de l'INRS-ETE. 23p.

[23]   Totin V.S. Henri, Amoussou Ernest et Boko Michel, 2007 : Dynamique de la mousson ouest africaine, régime hydrologique et maîtrise de l'eau dans le bassin supérieur de l'ouémé, Revue Climat et Développement, N°4, Décembre 2007, 46.

Employee Compensation Management in Nigerian Organisations: Some Observations and Agenda for Research

Obisi, C

Ph.D, Department of Industrial Relations and Personnel Management
Faculty of Business Administration, University of Lagos, Lagos, Nigeria
E-mail: obisi.chris@yahoo.com
Tel: +2348062775730

Uche, C.B.N

Ph.D, Department of Business Administration
Faculty of Business Administration
University of Lagos, Lagos, Nigeria
Tel: +2348023171571

Ifekwem, N.E.

Department of Business Administration
Faculty of Business Administration, University of Lagos, Lagos, Nigeria
E-mail: nkyifek@yahoo.com
Tel: +2348033253217

Abstract

Compensation management strategy at both private and public sector should be fair and equitable enough to help stimulate performance and ensure the realization of organization and corporate goals. When this is done, organizations can win competitive advantage. However this seems not to be the case as employees are under paid with its attendant industrial relations implications. There seem to be inadequate compensation, unfair compensation policies, with its resultant low productivity. Effective strategies and recommendations have been suggested.

Keywords: Compensation Management, Nigerian Organization, Equity.

1. Introduction

Employee compensation is an issue of continuing interests and forceful debate both in the private and public organizations. Employee compensation is the reward or payment for the services rendered by the employee - which may be in cash or in kind or both. It may also include the time worked or not worked or both.

Employee compensation is a volatile phenomenon. Organizations should strive to design and implement genuine and equitable compensation programme for their employees.

2. Objectives

    a. Examine the content of employee compensation administration in Nigerian organizations and evaluate their adequacies or otherwise.

    b. To bring into focus the inevitable consequences of wrong employee compensation administration.

    c. To examine the industrial relation's implications and effect of employee compensation administration.

    d. To proffer recommendations and suggestions towards the realization of equitable and reasonable employee compensation Management.

3. Compensation as a Motivator

Today, job fulfillment to many employees means increment in their compensation. There is very little awareness shown by employees (both public and private) about their accountability and social responsibility in their jobs. One can easily be made aware of his or her monetary privileges but not necessarily of his positive role in performing a job, Obisi (1996) Banjoko, (1995) wrote that inspite of the stage of our political and economic development, there remains a growing emptiness in the work life experiences of many Nigerians. Employees work today because there is no other choice and not that they look forward to something particularly rewarding (money) coming to them at the end of the Month.

No one can successfully contest that money is not the single most important motivating factor to a Nigerian worker. It is true that without money man cannot buy bread and without bread, man would not have energy to work. In as much as man does not live by- bread alone, he cannot live without it, Maslow (1954), Obisi, (1996).

The above generalizations speak eloquently on the place and importance of compensation in our lives.

Compensation Management in organization is a delicate and cost item. Organizations must handle it with care and make judicious use of it for optimum utilization of employee skills and returns to the organization. In a depressed economy like ours compensation Management has opened a Pandora's Box in terms of:

    a) Whether Millions of employees get what they deserve in terms of compensation?

    b) Whether what most people earn is enough to keep mind, soul and body going?

    c) What constitute an equitable pay?

    d) How flexible should wages and salaries be?

    e) Should pay be reviewed upward or downward?

    f) How is the compensation inequality between junior and senior employees?

    g) How is the nature of profit sharing in organization?

4. Compensation issues in Nigeria

Remuneration packages and the issue of flexibility and rigidity:

How flexible or rigid should the employee compensation package be (Longe, 1986) made it clear that a freeze truly depicts rigidity while upward and downward reviews would entail flexibility. Flexible compensation is generally accepted by the employees when it involves upward reviews.

However, Obisi, (1996) agrees with the views of (Lawler and Porter, 1971) that the first step in building effective reward practice is for the company to make sure that the rewards it is providing are ones which are widely desired. In day to day operations, we frequently forget that, regardless of the value the organization or individual places on a reward, its motivational influence comes about only as a result of the value the receiver places on it. In effect, rewards that the organization considers highly positive inducements may not be so regarded by many of the persons receiving them. At times compensation offers do not take into consideration the desires of the employees.

Many organizations put their employees in three or less working days a week and receiver less then their Monthly normal working rewards. Many organizations are calling for downward review of salaries in the name of flexibility and organizational effectiveness, Longe (1986). He also gave an example of flexibility in compensation with the British Caledonian Airways U.K. which went for"

rescheduling of pay. The employees accepted to forgo their pay increase for the time being due to economic recession.

Instances of salary reviews and freezes have been reported in various states like Bauchi, Benue, and Imo in Nigeria etc. Longe, (1986).

Ejiofor, (1983) supported that flexibility in compensation may aid economic recovery depending on the extent to which employees are motivated. According to him, Management owes it a duty to explain fully the implications, both short and long term.

Flexibility in compensations has its implication in economic recovery, motivation and morale. However, it should be transitory, temporary and not permanent and must have the blessing of both parties. Unilateral flexibility and reductions could be dangerous, with its industrial relations implications of unrest and strikes.

Table 1:　Total Emolument of University Academics.

Total Emolument of University Academics (Per Annum)		
Cadre Existing Emolument Per Annum		
	Minimum	**Maximum**
Graduate Assistant	**823745**	**943971**
Assistant Lecturer	946124	1144228
Lecturer II	1075509	1290761
Lecturer I	1356194	1750013
Senior Lecturer	2115717	2905070
Reader	2456847	3263287
Professor	2936121	3859079
Graduate Assistant	1678356	1834596
Assistant Lecturer	1966260	2223804
Lecturer II	2528784	2808588
Lecturer I	2889192	3401150
Senior Lecturer	4633212	5879388
Reader	5238595	6286836
Professor	6300120	7500000

Source: Academic staff of Nigeria University

Table 2:　Civil servants in Nigeria and their Emoluments

S/N	OFFICE/POSITION HELD	CURRENT WAGE (N)	AGREEMENT (waiting to be signed)
1	Professor (at the bar)	321,589,88	525,010.00
2	Local Government Councilor	1,129,647.92	
3.	Local Government Chairman	1,154,324.60	
4.	Ministers, SGF, Head of Civil Service, Chairmen of Boards	2,659,650.00	
5.	Justice of the Court of Appeal, Chief Judge of the Federal High Court, Chief Judge of the FCT, President National Industrial Court, Chief Judge of the State	2,743,716.50	
6.	Justice of the Supreme Court, President of the Court of Appeal	3,406,026,25	
7.	Chief Executive of Parastatal Agencies and Government Companies, Permanent Secretary, Executive Secretary (e.g. NUC_ Auditor General of the Federation, Director General	1,885,742,81	
8.	Special Advisers to the President	1,902,742.81	
9.	Vice Chancellors	1,833,333,33	
10.	House of Reps	2,991,666.67	
11.	Senators	3,066,666.67	

Source: National Salaries, Income and Wages Commission, the Presidency, Abuja. Budget Office of the Federation, Federal Ministry of Finance, Dec. 11 2008

5. Equity in Compensation

Compensation is the single largest item of recurrent expenditure in Nigerian public sector, Fashoyin, (l986). There has always being divergent views on how to determine compensation but there is unanimity of opinion that every organization should strive to reach equity in their compensation Management. Equity in compensation is fairness and justice in pay. Compensation equity is so worrisome that employees are not only concerned about what they are paid for the job done but also what others are paid. If a worker genuinely feels that what he or she is being paid is commensurate with the effort put in, equity is said to exist.

On the contrary, if an employee's compensation does not commensurate with his or her effort, a state of inequity seems to exist. The employee is said to be under paid, Obisi, (1996) Robbins, (1978) wrote that Employees are concerned with the absolute amount of money they are paid but also with the relationship of this amount to what others are paid. They perceive what they get from a job situation (outputs) in relation to what they must put into it (input). They also compare their output - input ratio with the output input ratio of their fellow workers. If a person's ratio and that of others are perceived to be equal, -a state of equity is said to exist. If they are unequal, inequity exists.

Stacy, (1975) echoed the same assertion when he adduced that inequity exists for an employee when ever he perceives that the ratio of his outcomes (pay, status, promotion) to inputs (efforts) and the ratio of other's outcome to others inputs are unequal. The unanimity of opinion is clear Beach, (1980) Aina, (1992) maintain that equal pay for equal work should be the guiding principle. However, this should not exclude a range in rates with individuals receiving different compensation within the range.

Foulkes, (1980) and the international labour organization (ILO) went a step further in their support for equality in compensation. (ILO convention, No 100, (1951) was uncompromising in its support for equality in compensation. It however concerns itself more on equality of compensation between male and female employees. According to it, Men and women should receive equal remuneration for work of equal value. Foulkes, (1980), did not only support efforts towards equity in compensation but went further by asserting that the overwhelming objective of compensation policies is to lead or at the least, be among the top employers in their respective labour market.

The Nigerian experience regarding equity has shown a pitiable state of affairs. Between the public and private sector employees, the equity gap is overwhelming. Adewumi, (1991) painted a painful picture of pay inequality between the two sector s in Nigeria. According to him what an office assistant in some private organization earns is very much higher than what a senior officer earns in a public sector organization.

Even in the private sector, compensation inequality exists among organizations belonging to same group. The international standard for industrial classification has classified industrial group into- (1) Manufacturing, (2) Banking finance and Insurance (3) Mining and petroleum (4) Construction (5) Commerce (6) services. However, we see disparities in compensation in same group. Adebo Commission, (1971) was critical of the private sector when it expressed its doubt on whether many employers of labour in the private sector do follow a scientific method of wages fixation and payments. Even the same can be said of the public sector today. There are many public sector organizations that have varied rates of compensation. Such organizations are:- The central bank of Nigeria, Nigerian maritime authority and even the Nigerian National Petroleum Corporation.

The consequences and implications for compensation inequality are unimaginable. It has a dangerous and destructive blow on commitment and morale of employees. If workers get equal pay for equal work or if their input is commensurate to output (rewards), it reduces tension. On the contrary, if compensation inequity exists it creates disequilibrium and disillusionment and dissatisfaction. However, establishing a genuine compensation structure would help organizations to contain the problem of equity in compensation.

6. Strategies for Genuine Compensation Management

There is a haphazard approach towards employee compensation management both in private and public organizations, Adebo Commission (1971) and Adewumi, (1995).

It is grossly unwise for organizations to pay too much, on the contrary, it is outrageously unethical and morally improper to pay too little. If organizations fail to lay a well contrived foundation regarding employee compensation, it would have its self to blame. A robust compensation policy and the implementation of such policy to the letter would contribute to organizations growth.

Compensation is determined by mainly economic and social factors. However political factor has come to stay Yesufu, (1984) According to Yesufu, wages and salaried earners constitute a veritable and peculiar force whose support many governments try to woo, through intervention in the determination or fixing of wages and salaries. Babawale, (1995) was at pain to point out how governments in Nigeria have used the announcement of wage reviews or relief packages more as a propagandas effort to gain political control rather than genuine responses to the yearnings and agitations of the workers. According to him, announcements are made by the federal government in respect of upward review of salaries without a corresponding release of funds to state and local governments to back up such announcements in concrete terms. We also see in private sector where pay increase has been regarded as a privilege by certain organizations instead of the right of the employees.

Promises regarding compensation are made "but no genuine implementation. It is true that something is wrong with the pay structure in various organization which accounts for various commissions which we have had. Various commissions have been set up to look into the issue of wage determination and all point to underpayment. The Adebo Commission, (1971) "the Udoji Commission, (1974-) and the Onosode Commission all agreed that the .Nigerian worker is worst off.

Compensation is determined by such factors as:- The organization's ability to pay, supply and demand of labour, the prevailing market rate, the cost of living, the living wage, productivity, Trade Union's bargaining power, job requirements etc. However collective bargaining has come to stay as the chief determinants of employee compensation and reward. Fashoyin, Matanmi and Tawose (1994) found that the most overriding concern in the determination of organizational employee compensation is with collective bargaining between the actors in industrial relations. According to their findings 41% was for collective bargaining, 21% ability to pay, 20% productivity, and 15% acknowledged the adoption of industry/civil service unified salary scale. However 8% of the sampled organizations appreciated the use of combination of the above mentioned four factors.

Whatever may be the arguments regarding employee compensation in Nigerian organization particularly public organization, the truth is that it is grossly inadequate.

Government is aware of this but it blames it on paucity of funds. Adebo Commission, (1971) was very frank when it said: To press for a general increase in wages and salaries in a condition of stagnant production and critical foreign exchange shortage would amount to claiming in real terms what simply does not exist. The above statement sends demoralizing signal to employees and government must come out with better means of improving the quality of work life of the employees of this country. Ejiofor, (1984) found that 85% of the survey population of more than 110 were not satisfied with their compensation packages. Longe, (1986) was of the opinion that the major existing methods of determining remuneration packages in the public and private organized sectors are by wages and review commissions and through collective bargaining between employers and employees.

The world of employees in Nigeria is baffling and terrifying. Workers in this country live under special difficult conditions because their income cannot meet up the cost of living. Reckless increases in essential commodities including transportation reduce the value of workers salaries.

7. Organizational Policies vis-à-vis Compensation Structure and Rates

In Nigerian organizations, compensation packages include the following:- Pay for normal time work, overtime pay for excess hours worked, pay for working shift, pay for working at night, Incentive pay for meeting or exceeding target, profit sharing, year - end gift, or Christmas Bonus, cost of living

allowance (COLA), transport Allowance/subsidy, Housing Allowance/subsidy, Medical Allowance for members of the employee's family etc. There are also other Earnings for time not worked which include: Paid Annual, casual, sick and maternity leave, paid public holidays, work free days and day-off, gratuity-both service and Retirement, Employer's contribution to HPF, old age pension scheme, social security etc. There, are also other payments in kind: Free or heavily subsidized meals at the expense of the employer, free gift of products by the employer, payment of Electricity/gas bills by the employer, free accommodation or subsidized accommodation by the employer, free drinks in the employers bar or restaurant, lunch vouchers, fuel vouchers, free Uniforms, free Medical services by the employer, free company vehicle etc. Uthman (1988).

According to Fashoyin (1988) Uthman (1988) increases ranging from 100% or more have taken place including on transport and housing for both junior and senior staff but that has not brought much respite. Proper harmonization of compensation structure would go a long way in cushioning the harsh effects of low compensation.

Organizations could take the following steps in establishing a robust compensation structure and rates.

1. Jobs must be properly analyzed and examined so that the right man could be placed on the right job.
2. Performance standards must be set so that targets to be achieved by every employee be known. This would enable the organization to carry out proper performance reviews.
3. Job evaluation must be done so that Job's worth in the organization could be determined.
4. For organizations to remain dynamic with, regard to their compensation, they must carry out regular wage surveys to avoid paying less than the prevailing rate in similar organizations.
5. Various wage legislations in a country must be taken into consideration while organizing and implementing compensation plans.

8. Industrial Relations Implications of Employee Compensation Administration

Industrial relations implications of employee compensation would depend on organizations compensation structure and rates. If an organization's compensation policies go to attract and retain qualified personnel, bring about equitable pay for work done, equal pay for equal work and promoting a relationship between pay and commitment to organizational goal. Such compensation structure would have positive implications and reactions from employees and employers. However rigid and awkward centralized compensation policy would create unpleasant implications. Fashoyin (1992) explained that rigid and centralized wage policy create difficulties for employers in terms of adjusting their wages and compensation as a means of providing incentives for good performance and efficient allocation of human resources. The productivity, prices and income Board wrote that during the period 1976-82, employers and labour were constantly looking for avenues to bypass- the policy in order to relate wages and compensation on their particular situation, Fashoyin, (1984).

Every compensation policy should strive to achieve economic and social objectives and should be reasonably flexible to meet the needs of the time.

8.1. Organizations Compensation and Challenges Ahead

It is the task of every organization to match towards equitable and adequate compensation rates. It is vital that more deregulation and more flexible approach towards employee compensation are followed. Adhoc approach in the public sector could be substituted with the more democratic process of collective bargaining. Matanmi, (1994) Tawose (1994) found support with Fashoyin, (1992) that collective bargaining and agreement making have been perceived as the most critical method of determining organizational pay structure.

Government must overhaul the wages policy in Nigeria. The first and right step is a revisiting of the National minimum wage. It is due for a review. Our minimum wage is painfully and miserably low. It cannot stop an average and humble employee from starving to death. Discrimination in profit sharing must come to an end. We see it today that executive compensation in many private organizations is out of tune with reality:-

There is so much rigidity in pay negotiation in the public sector due to wages and income policy guide lines which does not give much flexibility between management and labour to negotiate and renegotiate pay increases, Fashoyin (1992). Third National development plan (1975) was not impressed with the inability of the public sector employer to engage in real collective bargaining. The third national development plan called for the establishment of a permanent agency for the continuous evaluation of trends in incomes, prices and costs as a reliable basis for the review of wages, salaries and taxes in the public and private sectors of the economy. This would be a welcome trend considering the instability and fluctuations in the economy. Conditions and situations do change and an agency to monitor these changes would be a right step. According to the Productivity, Prices and Income Board (PP1B) which is the agency for formulating incomes policy guidelines for approval by government rigid income policy does not give union and employers the handle to adjust wages and compensation to boost the morale of the workforce. It is therefore time to make amends in terms of flexible compensation policy both in the private and public sector.

9. Recommendations and Suggestions

Available importance and evidence show that workers are under paid both in many public and private sector organizations, however, executive pay in many organizations in the private sector is not realistic because performance of the organization and individual is not taken into account. Lazesr (1992) points out that while organization equates pay to performance, they should be prepared to identify and measure all components of output. Enlightened Management would normally relate pay to the performance of the organization and individual. In various organizations, executives are paid so much even if those executives perform below expectation. It is of late that certain organizations particularly in the depressed banks that the owners are calling for downward review of salaries just because their banks are distressed and the entire organization is not making profit. The right step should have been to equate pay with performance. If executives do not perform, they should not be paid so much. Pay policy should be even for all levels of employees.

If organizations make profit, it should be shared, even and not discriminatory system whereby the lion share is cornered by the executives and the lower level workers left stranded. However in a difficult time workers and Management should show maturity and understanding regarding compensation issues though workers are always persimistic that they would be forgotten in terms of boom. If workers and Management are not willing to sacrifice, even a good industrial concern may go in doldrums.

However if worker's come to co-operate on their own to increase productivity and sacrifice bonus in the transitional periods, the proper foundation laying would come out successful. This solution oriented approach would go a long way in creating a positive atmosphere of loyalty, sacrifice and spirit of co-operation. However, if workers continue inclination to behave in an irresponsible manner, Management's immediate reaction is to substitute men by machines, formally Managements do not want to fulfill their own commitment towards development of the workforce. They would definitely opt for retrenchment if workers are not co-operative regarding compensation. However this skin-shaving approach should, be avoided regarding the social and economic implications of such a step.

It is true that the Nigerian worker is worst off both on and off the job. The quality of work life of the Nigerian worker has worsened and has infact reached frightening proportion, Banjoko (1995). The only way out is a well-contrived policy at both national and organizational levels. The first steps at the national level should be:-

    a. A permanent structure or agency to monitor variations and fluctuation in individual income to keep pace with economic changes.

    b. Political stability which would in turn bring about economic stability and prosperity.

    c. Price stability. The prices of essential commodities are raising everyday. Naira's worth is losing value everyday. It is necessary for now for government to stabilize prices by indicating the price on any item purchased. Using of weight or sales by scale should be introduced to save Nigerian workers from the hands of unscrupulous and over greedy traders. This system has been successful in many countries of the world. It is criminal fleecing for a low paid worker to go to Yaba market and see traders selling their goods at various exorbitant rates. The rates in the morning hours may not be the same in the evening. Low paid Nigerian worker cannot cope in a situation like this. If governments can liase with companies to fix the prices on every item they produce with certain percentage of local taxes extra for or packed goods, prices would stabilize. Again if the vegetable, rice, yam and other food sellers would be mandated to use weights or scales to sell their goods. For example, if every rice, yam or vegetable seller has weights or scales in his or her shop and prices are fixed in kilogrammes, a buyer would know that a kilogramme of rice, yam or bean costs ₦20 naira rather than multiplication of prices which has become the order of the day.

    d. Transportation: Government and the Nigerian people must now stabilize and rationalize transportation, charges. The era of arbitrary fixing by transporters, drivers, conductors, arrear boys and other anti-social element must stop. I entered a bus from Ojuelegba to Adeniran Ogunsanya along Bode-Thomas around 8.am for ₦5 but while returning in the evening I was told to pay ₦10. I asked why and was readily informed that some anti-social elements have put pressure on bus drivers to increase the fare so that they can have their own share. If Mr. X takes a cab from the national stadium in Surulere to C.M.S. on Victoria Island, he may pay ₦100. And if Miss. or another Mr. Y takes another taxi from and to the same place, he may pay up to ₦150 naira. Low paid Nigerian worker cannot survive this kind of situation. It is depressingly bizarre. The only way out is metrerised transport system within the same locality or uniformed pay system. If every cab or bus is fixed with metre and passengers would pay according to metre reading in kilometers. If government and transporters would sit down and fix appropriate fair a kilometre drive. This would bring uniformity and discourage erratic charging in fares. Alternative means of transport is also recommended.

    e. The Minimum wage should be revisited. It is time for a hard look at Nigeria's minimum wage. It is unrealistic. It is overdue for a review.

The steps at the organizational level would be:

    1. Effective managing of human resources through training and development.

    2. Wages and other benefits should be equitable and provide good quality of work life which would raise the morale and performance of the workforce.

    3. The worker should in turn reciprocate management's efforts because compromise, understanding and interdepence are a challenge as well as an opportunity for organizations to achieve their goals.

The above inferences if implemented would bring solace to Nigerian workers.

10. Summary and Concluding Remarks

It is evident from available information that majority of the Nigerian workers are under paid. It is also evident that at times personal influences rather than merit determine compensation rates in various organizations. It is also evident that our reward system does not always depend on employee performance and contribution. As it is today, many Nigerian workers are disenchanted, disillusioned

and dejected while some are reaping more than, they are working. It is time for a balanced approach. Too much talk and no positive action would not do organizations any good.

Our compensation and rewards policy, structure and rates must be over hauled particularly in the public sector and some levels in the private sector. Here renovations of policy, structure and rates would not render the much needed solace.

References

[1]   Adebo Commission, 1971. Pay Reviews in Nigeria, Commission Report, Lagos.
[2]   Adewumi, F., 1995. Pay Determination in the Public Sector. Fredrick Ebert Foundation Seminar, University of Lagos.
[3]   Aina, S., 1992. "Personnel Management in Nigeria" *Publication*, Nigeria, pp. 126.
[4]   Babawale, T., 1995. Minimum Wages, Salary Awards as Political Weapon, Book of Readings Department of Political Science, University of Lagos.
[5]   Banjoko, S.A., 1995. "Towards improving the quality of work life in Nigeria: The role of government". *Nigerian Journal of Management Studies*, 7, number March
[6]   Banjoko, S.A., 1996. Human resources management: An expository approach. Lagos: Saban Publishers.
[7]   Ejiofor, P., 1984. "Managing the Nigerian Longman Nigeria, Empirical finding" *Nigerian Journal of Industrial Relations*, pp. 25.
[8]   Fashoyin, T., 1986. Income and Inflation in Nigeria Lagos and London Longman.
[9]   Foulkes, F., 1980, "Personnel Policies in Large Non-Union Companies: Englewood Cliffs", Prentices Hall, pp, 17-44.
[10]   Lawler, E.E., 1971. "Pay and organizational effectiveness: a psychological view". New York, McGraw-Hill.
[11]   Longe, F., 1986. Flexible remuneration as an option in a recessionary economy 1 p.m. monograph.
[12]   Maslow, A., 1954. Motivation and Personality Harper and Row, New York.
[13]   Matanmi, F., 1994. Reform measures, employment and Labour and Tavose Market processes in the Nigerian Economy
[14]   Obisi, C., 1996. "Personnel Management" *Freeman Publications,* Ibadan, Nigeria.
[15]   Porter, L. W., and E. E. Lawler, 1968. Managerial Attitudes and Performance. Homewood, IL: Richard D. Irwin, Inc. pp. 183 -184.
[16]   Smith, R.D and E.M. Burrack, 1977. Personnel Management: A Human Resources systems Approach.
[17]   Stacy, A., 1975. Inequity in social change quoted in steers, Richard and L Porter, Motivation and work behaviour McGraw, Hill Book Co., New York, pp. 141.
[18]   Stephen, P.R., 1978. "Personnel the Management of Human Resources", Englewood: Practice Hall, 270. pp. 20.
[19]   Yesufu, T.M., 1984. "The Dynamics of Industrial Relations: The Nigerian Experience", Ibadan University Press Ltd., pp. 153.

Strategic Orientation, Survival and Development of Trade Unionism and Trade Unions: An Inward Looking Approach

Chris Obisi

Ph.D, Department of Industrial Relations and Personnel Management
Faculty of Business Administration, University of Lagos, Lagos, Nigeria
E-mail: obisi.chris@yahoo.com
Tel: +2348062775730

Francis C. Anyim

Ph.D, Department of Industrial Relations and Personnel Management
Faculty of Business Administration, University of Lagos, Lagos, Nigeria
E-mail: chucksanyim2004@yahoo.com
Tel: +2348033468317

Uche, C.B.N

Ph.D, Department of Business Administration
Faculty of Business Administration, University of Lagos, Lagos, Nigeria
E-mail: obisi.chris@yahoo.com
Tel: +2348023171571

Ifekwem, N.E.

Department of Business Administration
Faculty of Business Administration, University of Lagos, Lagos, Nigeria
E-mail: nkyifek@yahoo.com
Tel: +2348033253217

Abstract

Trade unionism and Trade Unions have come a long way in Nigeria and has sustained deliberate state and environmental obstacles coming in its way of survival and growth. This paper among other issues would look at the journey so far and come up with strategic solutions to advance the cause of Trade Unionism and Trade Unions. More importantly, it is the opinion of this work that the progress and demise of Trade Unionism and Trade Unions lie in their hands through their actions and inaction as the greatest enemy of Trade unions could be the Trade Unions themselves.

1. Introduction

Industrial relations would not exist and be sustained without effective trade unionism and trade unions and as a result trade unions should take its pride of place in the system of industrial relations so that it can become an equal partner rather than playing the role of an underdog.

Without strategic orientation of trade unions which will enable trade unions to have a strong desire and passion to excel, knowledge of their local and international environment, acquisition of strategic skills, progressive mission and vision strategy, it would be very difficult for trade unions in Nigeria to survive, let alone develop and transform.

As it is Nigerian trade unions do not have adequate capacity to match vicious management who can derecognize unions at the wave of a hand and continue to retain wrong perception about labour.

2. Objectives of the Paper
The major objectives of this paper are to:
- Highlight the urgent need for continuous trade union orientation and development without which the trade unions will not be able to outline and see through the demands made upon them by the ever rapidly fluid environment.
- To catalogue the various steps to be taken to reposition Nigeria Trade Unionism and trade unions.
- To articulate the capacity building areas to make trade unions become an equal partner in industrial relations rather than play the role of an underdog.

3. Strategic Orientation
Strategic orientation as Armstrong (1995) writes is the approaches and steps adopted when focusing on long-term issues and setting the overall direction. Strategic orientation should indicate vital result oriented activities.

Strategic orientation for trade unions should be able to contribute to the overall sustainability of Trade Unions and trade unionism and adding value to industrial relations.

Strategic orientation for trade unions should be able to explain and imbibe in trade unions the understanding of their
- mission
- vision
- values, culture, style
- trade union philosophy
- an approach to the management of its members
- skill acquisition and development
- commitment
- Productivity, Armstrong (1995).

Tyson and Witcher (1994) suggest
- Strong, visionary and often charismatic leadership from the top.
- well articulated missions and values
- a clearly expressed processes of doing things
- a positive focus on well-understood critical success factors

Strategic orientation should clearly link where the union is now, where union wants to be and how and when it will get there.

Trade union orientation apart from dealing with broad long-term success issues should be able to create and inspire a strong desire for
- performance/result
- knowledge and understanding of the world around unions
- rejection of obsolete skills
- Union orientation should be able to inform and clarify policies, members expected roles, health and safety measures, etc.

Adequate orientation would bring about motivation and induce in the individual and create awareness about what is going on in and outside the union. It is also important that orientation be continuous in order to update union members about trade unionism and Industrial Relation.

4. Strategic Orientation and Trade Union Culture

Trade union culture is the way trade unions live their lives and get things done.

Strategic orientation of union should be able to imbibe trade union culture and philosophy to all its members. Positive culture will go a long way in enhancing survival and development of trade unions but when it is negative, it would surely hinder union development and sustainability. Orientation of trade unions would expose them to union beliefs, norms, attitudes, ethos etc.

Trade union culture can be managed through culture change whereby negative culture can be eliminated and positive union culture reinforced. For example, simple living and high thinking, solidarity for ever, commitment and social justice are indispensable to union existence.

According to Schein (1987) union culture can be managed by what union leaders pay attention to, measure and control. He further adds that leader's reactions to critical incidents and crises, deliberate role modelling, teaching and coaching by leaders, criteria for allocation for recruitment, selection, promotion and commitment are the tools for managing union culture.

Proper orientation of unions would help them

- Have focus and guides it to achieve its goals
- Help in creating a sense of belonging and unity of purpose
- Help in imbibing commitment and loyalty particularly when the culture is positive and dynamic.
- Help to provide the much needed guidance for behaviour modification which is sine-qua-non to trade union orientation, survival and development.

5. Trade Union Survival

Section 1 of the Nigerian Trade Union Act, 1973, defines a trade union as "any combination of workers, or employers whether temporary or permanent, the purpose of which is to regulate the terms and conditions of employment of workers whether the combination in question, would or would not apart from this Act, be an unlawful combination by reason of any of its purposes being in restraint of trade and whether its purposes do not include the provision of benefits for its members.

Otobo (2005) explaining away the above definition writes that as there are salaried and commissioned employees in several bonafide unions, we need not, by definition, limit union membership to wage earners as according to him, unions come in all shapes, sizes and mixes of goals and activities. He further argues that almost without exception, unions in Nigeria differ from other types of organisations because of their bargaining relationship with the employers of their members as employers' organisations by law are also trade unions.

Otobo (2005) writes that though in practice we apply trade unions to only the workers organisations. A trade union is generally a continuous organisation of employees that seeks to maintain and improve the terms and conditions of employment through collective bargaining representation with the employer (from which it remains autonomous) and through other means.

The odds against trade unions in Nigeria are daunting. Issues like casualisation, the underdog role of unions, lack of proper financial administration, illiteracy, poverty, weak organisation, divisions among union, unfair attitude of employers, government intervention and meddlesomeness, low membership, poor conducive environment, quality of work and work-life balance, corruption, role clarification, social, economic, political and spiritual character of unions, union recognition and derecognition.

For trade unions to come out of the ordeal of survival let alone transformation must address the above issues proactively and professionally so that they can as Armstrong (1995) puts it with the help of all the stakeholders

- Build stable and cooperative relationships to minimize conflict
- Achieve commitment through involvement and communications processes and develop.
- Mutuality – a common interest in achieving the organisation's goals through the development of organizational cultures based on shared values between trade unions and management.

6. The Role of Trade Unions

Lack of a viable political culture where there is virtually no opposition parties in Nigeria has put unions in a difficulty position and must therefore brace up to play strategic roles in organizational as well as national development. Otobo (2008) explains that labour must begin to question some of the underlying assumptions of globalization as a theory of development.

- Labour should continue with vigour to challenge the claim that the best way forward is to have an unregulated economy where all transactions are left to the market forces.

Otobo argues that even in the USA government subsidies agriculture to the tune of billions of dollars and the European Union subsidizes agriculture, health, education and a variety of social insurance schemes.

It is now known that in the UK, you can have university education now and pay latter which is quite different from Nigeria.

- Labour must continue to oppose laize-faire because it has not worked as it was abandoned in the past. The global economic meltdown was indeed the offshoot of laize-faire.

Otobo further encourages unions to add more impetus in the following areas:

- Transparency in governance and business
- Activities directed at getting all to respect and protect human rights should be increased and encouraged.
- Unions should do more networking with other non-government organizations, including student organisations, civil society etc.
- With the emerging civilian democracy, trade unions should respond more proactively to a more benevolent socio-political situation characterized by positive expectations from the citizenry.
- Unions should encourage some degree of deregulation and privatization in some sectors of the economy dominated by highly inefficient publicly-owned companies.
- Unions should have more capacity to organize as their membership is being depleted due to layoffs, poor management, economic meltdown, redundancies etc.
- Trade unions must increase its ranks by organizing casuals, short-term contract workers, in addition to taking legal steps to compel employers to keep terms of agreement.
- The quality of union leadership should improve
- Freeman and Medoff (1984) described the following as the role of trade unions:
- To provide workers as a group with a means of communicating with management – a collective voice – which can bring actual and desired conditions closer together.
- Secure through collective bargaining, improved terms and conditions for their members.
- Provide protection, support and advice to members as individuals.
- Provide financial, legal and other services to members

Armstrong (1995) also adds other roles of trade unions as that of acting in partnership with management in improving organizational effectiveness, to the benefit of both the organisation and the union members. However Cave (1994) suggests the following roles:

- *Champion* – lifting the floor of the labour market to improve minimum pay and standards.
- *Equalizer* – attempting to eradicate differentials based on gender, race, and location.
- *Ladder* – enhancing skill development and promotion opportunities.
- *Regulator* – imposing or defending workplace rules limiting managerial license to act.
- *Membership club* – providing a new range of financial services.

7.1. Capacity Building for Trade Unions

It is our strong assumption that trade unions have unions in Nigeria has not built enough capacity. This capacity to us is both professional and academic but we would argue more forcefully that they need very urgently more of orientation, reorientation, induction and more indoctrination and continuous follow up. Trade unions should take the following deliberate steps to continuously build capacity without which it cannot play its roles effectively.

Continuous learning and development and build a learning organisation which Pedler *et al* (1989) calls the facilitating the learning of all its members an continually transforms itself.

Mamoria (1995) explains that with learning and development environment, trade unions skills, knowledge, habits and attitudes are acquired and utilized in such a way that behaviour is modified.

Effective learning and development would help unions acquire the much needed knowledge, skill and attitudes which are needed for sustainability.

7.2. Trade Union Empowerment

Learning and development would bring about empowerment of trade unions to become competent, trusting and could bring about teamwork which will bring about responsibility and accountability.

8. Conclusion

A forward looking, long-term, result oriented strategies are required to enable trade unions survive, develop and be sustained. The present decade has been an unpleasant time for trade unions with the problems of unending casualisation, recognition and derecognition, low capacity, internal and external environmental challenges, at times self inflicted, legal impediments, decline in work ethics, lack of respect to collective agreement, absence of well thought-out government and management policies, outdated labour laws, low organizational capacity etc are daunting for trade unions. Strategic orientation and repositioning will bring about the much needed sustainability with the firm conviction that all the stakeholders would play their part positively. Trade unions of today should be more highly developed than their forerunners. They should understand a wide range of functions and should have a clear understanding of their objective and goals. They should be more pragmatic in their approach. If they are not careful, they will not measure up to the expectations of the dynamic environment. Without continuous orientation, and development, premature inclusion of trade unions in management will lead to their being silenced effectively by management or if they are made of sterner stuff, they will inspite of the best intentions prove obstructive and resentful towards management, V.V. Giri (1987).

References

[1]   Armstrong, M., 1995. "A handbook of Personnel Management"*, Kogan* Page London.
[2]   Cave, A., 1994. "Organisational Change in the Workplace"*, Kogan* Page, London.
[3]   Freeman, R and J. Medoff, 1984. What do unions do? *Basic Books*, New York.
[4]   Otobo, D., 2005. *Why Trade Unions exist and Trade Union Rights Project on the Installation of Alternative Dispute Resolution Mechanism (ADR) for Labour Officers and Social Partners,* Federal Ministry of Labour Abuja, Nigeria.
[5]   Pedler, M.; T. Boydell, and J. Burgoyne, 1989. "Towards the learning Company" *Management Education and Development*, 2-1, pp 1 – 8.
[6]   Schein, E.H., 1987. "Organisational Culture and Leadership", Jossey Bass, New-York.
[7]   Tyson, S. and M. Witcher, 1994. "Getting in gear: post-recession HR Management"; *Personnel Management,* August, pp. 20-23. London.

Iran's Transition to Learning Economy: Exploring the Intervening Role of Information and Communication Technology

Seyyed Hamid Khodadad Hoseini

Department of Management, Tarbiat Modares University
Jalal Ale Ahmad Highway, Tehran, Iran
E-mail: khodadad@modares.ac.ir
Tel: +98-2182884673

Behnam Abdi

Corresponding Author, Department of Information Technology Management
Tarbiat Modares University, Jalal Ale Ahmad Highway, Tehran, Iran
E-mail: babdi@modares.ac.ir
Tel: +98-2182884673

Alireza Hassanzadeh

Department of Information Technology Management
Tarbiat Modares University, Jalal Ale Ahmad Highway, Tehran, Iran
E-mail: ar_hassanzadeh@modares.ac.ir
Tel: +98-2182883637

Ali Mohammad Ahmadi

Economics Research Institute, Tarbiat Modares University
Jalal Ale Ahmad Highway, Tehran, Iran
E-mail: aahmadi@modares.ac.ir
Tel: +98-2182883901

Abstract

In the last couple of decades, developed countries have shown high economic growth by knowledge creation and diffusion in the whole of economy, i.e. they had a great transition to knowledge-based economy. In contrast, attention to different paradigm is a necessity for developing countries such as Iran, the Islamic Republic of; where sale of natural resources such as raw oil is the main source of national income. So in this qualitative research, we investigate the themes and components of Iran's transition to learning economy by using grounded theory approach. Findings show that one of the fundamental challenges in Iran's transition to learning economy is providing an enabling environment of excellent information and communications technology (ICT). ICT have been at the heart of economic changes for more than a decade and plays an important role, notably by contributing to rapid technological progress and productivity growth. Elimination of digital divide between regions and at national level, ICT's infrastructure development and e-government development are the related important components that should be considered in Iran.

Keywords: Learning economy, Information and Communication Technology, E-Government, Digital Divide, ICT Infrastructure, Iran

1. Introduction

Most developed economies have undergone significant structural changes in recent years. One of the key characteristics of the changes is the growing importance of knowledge in all sectors of economic performance that result to the emergence of knowledge-based economy (OECD, 2000), where the generation and diffusion of new technology and knowledge flow with a much faster speed to enhance competitive economic development. The knowledge-based economy has become the major trend in international society in the 21st century (Hsu et al., 2008). Exploring the characteristics of the knowledge-based economy and establishing an appropriate economic paradigm for accelerating technological innovation is an urgent task for governments (Hsu, 2001). Moreover, there are strong indications and emerging trends that there are qualitative and quantitative differences between the 20th and the 21st century drivers of economic growth: The world economy is in the midst of a profound transformation, spurred by globalization and supported by the rapid development of information and communication technologies (ICT) that accelerates the transmission and use of information and knowledge (Carayannis, et a., 2006). Therefore, in a knowledge-based economic system, the issues concerned with the challenges and the adaptation of competition policy require profound discussion. However, merely possession of knowledge does not guarantee an edge in competition (Mu et al., 2010) and the most important trend shift is not the more intensive use of knowledge in the economy, but rather that knowledge becomes obsolete more rapidly than before (Lundvall and Johnson 1994; Lundvall and Borras 1998); therefore it is imperative that firms engage in organizational learning and that workers constantly attain new competencies (Lundvall et al., 2008). In the other word, knowledge has been considered the most important resource and learning the most important process (Lundvall, 1999) for economic development. So it is the learning capability of society which is essential for developing and maintaining a sustainable competitive advantage and there is a need for simultaneous organizational, institutional and technological learning. This involves different types of knowledge of which the less formalized and experience-based are often just as important as the formal knowledge that learnt in formal education systems. National economies are moving towards this aggressive learning and from here emerges the concept of learning economy (Lundvall et al., 2008).

The learning economy is based on the idea that learning and innovation is an interactive, cumulative process, which depends on the structure and change of the institutional set-up of the economy (Lundvall, 1992; Johnson, 1992). Learning, in this sense, is the process of (continual) change in institutional and organizational forms and economic structures (Lundvall et al., 2006). That is why socio-institutional systems that are able to transform their structures in reaction to the paradigm shifts — and thus successfully adapt themselves to new circumstances — can be called learning economies. The learning approach emphasizes a dynamic approach to innovation rather than the more static approach adopted in the knowledge-based economy that emphasizes access to a stock of specialized knowledge (Cappellin, 2007). The concept of economic learning captures the notion that some economies seem to be able to accommodate changes (e.g. products, technologies, and markets) better than others. They do so partly through the flexibility of their firms themselves, but also through their capacities to promote inter-organizational linkages and collaboration and, above all, through the capacity of public institutions to imbibe and develop innovations, and then disseminate those innovations in various forms to firms, thus accelerating the process of adaptation (Carayannis et al., 2006). The globalizing learning economy offers both new opportunities and new threats for emerging economies. Several of the Asian economies have become more integrated in the global value chains that constitute an important characteristic of the globalizing learning economy and this has helped them to achieve high growth rates (Lundvall et al., 2006). On the other hand, most Asian countries such as Iran were not successful in this relation.

Iran's 1404 development vision indicates that in the horizon of the next two decades (in year 2025), Iran is a developed country, with a first rank of economic, scientific and technological status in the region… according to this vision, several 5 years plan's has been formulated and implemented to attain the final goal, the first rank in the Middle East. The 5th five years development plan has been started in 2012. Iran's development model, however, has largely relied on a government-led strategy based upon the growth of oil industry. This model started in the early 1950's with the nationalization of oil industry. Because of Oil-based economy, rentier industries have played a leading role in Iran's economic growth. In spite of the government's effort for developing the non-oil exports, the successes in this relation are limited and more than 90% of national income is due to sales of raw oil. Although there are some primary successes in attain the goals of development plans such as increasing number of students and teachers in higher education and government expenditures in education (as a parentage of GDP), R&D expenditures as a percentage of GNP and some other science and technology indicators, there is not sufficient and real progress toward the vision as a outcome of these efforts. The most important change is in the published academic articles and it's ranking in the world (27 in 2008, 22 in 2009, and 16 in 2012) (Regional Information Center for Science and Technology, 2012). On the other hand, some indicators such as the rank in knowledge based economy (98 in 2009 and 96 in 2012) (World Bank, 2012) (Table 1) and rank 64 in economic competitiveness between 144 countries in the world represent a great contradiction. The increasing trend of published articles is a result of Iran's Ministry of Sciences, Research and Technology policy and regulations about ranking of universities, teachers and students in higher education based upon the number of published articles, without any attention to the articles' quality and their relevance to the operational problems of the society that should result to problem based solutions. All academic fields – such as basic sciences, engineering, and humanities- are equal in relation with these regulations.

Table 1:   Knowledge based economy in Iran in comparison with other countries (World Bank, 2012)

Indicators	Sweden	Korea, Rep.	Turkey	Iran
Knowledge economy index	9.43	7.97	5.16	3.91
Knowledge index	9.38	8.65	4.81	4.97
Economic incentives and institutional regime	9.58	5.93	6.19	0.73
Education	9.74	9.09	5.83	4.61
Innovation	8.92	8.8	4.11	5.02
ICT	9.49	8.05	4.5	5.28

Although innovation studies stressing non-linear and heterogeneous innovation processes; and work on organizational learning and the reflexive activities of players in the innovation process (see for example: Edquist, 1997; Lundvall, 1999; Mathews, 2001), policy maker's approach in Iran unintentionally focused on linear model of innovation, which is timely and costly. The dominant approach is based upon linear model of innovation and the governance style in national innovation system is authoritative in Iran (Haji Hosseini et al., 2011) and the level of innovation is less than what is expected (Supreme Cultural Revolution Council, 2003). Evidence from development plans showed that policy makers have unequal and divergent perception about the development plans and they don't follow equal innovation strategies (Khodadad Hosseini, et al., 2012). Beside, Evidence showed that there are no suitable and equivalent outputs with inputs in research, education and etc. (National Research Institute for Science Policy, 2008). On the other hand, the quality of academic researches accordance to social and economic needs is a serious concern (Fakour and Haji Hosseini, 2008; Bruton et al., 2008), but there are no success for universities in initiating research co-operations and increasing the cooperative spirit (Ghaneirad et al., 2008) and in establishing a relationship with scholars and researchers in the other scientific areas (Paya, 2008). The individuals and collective patterns of knowledge production are heterogeneous (Ghaneirad et al., 2008), thus, it is the time to switch to a new model of education in Iran that promotes quality, creativity, and multi-facet learning. In the other word,

the need for a transition is inevitable in Iran but it blocked by old and hierarchical structures, by policy makers who is responsible for decision making, by institutional inertia and as a result, by the old growth model. Thus, these presented issues, lies very much in the view on how such a transition has really taken place in a specific country like Iran? What factors are important in relation with this transition?

Within this general framework, the paper follows the next structure. In the next section, we provide a brief literature on learning economy and an overview of the role of ICT and its economic importance. We then discuss our methodology and presenting results. The conclusion and policy implications are presented in the last section.

2. The Learning Economy

Lundvall has been in the forefront of those stressing the need for an increased emphasis on learning in the new economy, arguing that it may be more appropriate to describe the emerging paradigm as a "learning economy" rather than a "knowledge-based" one (lundvall, 1992). The concept of the learning economy may represent an evolution of the knowledge economy (Cappellin, 2007). In various contexts, Lundvall and Johnson (1994) have introduced an interpretation of what has actually taken place in the economy over the last few decades under the heading 'the learning economy'. Learning in this respect refers to the building of new competencies and the acquisition of new skills such as social learning (Hyysalo, 2009) and technology learning (Qu et al., 2013), not just gaining access to information. They use the concept of 'learning economy' when referring to the contemporary post-Fordist economy dominated by the ICT-related (information, computer and telecommunication) techno-economic paradigm in combination with flexible production methods. In a learning economy, competitive advantage is based upon exploitation of unique competencies and resources, i.e. a firm or a region/nation competes on the basis of what they have which is unique in relation to their competitors (Asheim and Coenen, 2006). Lundvall (1996) argues that the concept of a learning economy can be used in two interconnected ways; partly as a theoretical perspective on the economy, and partly as a reference to a specific historical period in which knowledge and learning has attained an increasing importance in the economy, and, thus, is requiring a new theoretical framework for it to be analyzed. Perez (1996) maintains that a new techno-economic paradigm based upon information technology has become hegemonic, which highlights the problem of socio-institutional inertia, and calls for a new institutional framework to recreate a match with the techno-economic paradigm as the structural basis for stable growth and prosperity.

For a learning economy to be established, especially in developing countries, access to international knowledge, access to or diffusion and utilization of the tacit knowledge, interdisciplinary activities and learning based upon practical problems are needed to enhance the capabilities to learn and innovate. The way to link the theoretical universe to practical problems may be to let students conduct experiments and find technical solutions to specific problems. Lam (2000) also points out that the skills required for knowledge interfacing within and between collective learning processes tend to be highly time-space specific. The relevant knowledge base for many industries is not internal to the industry, but is distributed across a range of technologies, actors and industries (Smith, 2000).

We argue that moving from invention to innovation often needs to practical and experience-based interaction between different actors in national education system. Supporting communicative and collaborative skills is a major task of the education system. Traditional schooling isolated from other parts of society and organized according to traditional disciplines and educational methods, is insufficient in the context of the learning economy. Educational principles and cultures focusing on collaboration, interdisciplinary and engagement with real-life problems are needed to prepare people for flexible and innovative participation in the economy and society. The only way out of this problem consistent with Persian history would be to invest massively in new model of education and training system. In spite of the important issues in learning economy that developing countries can benefit for being integrated in the global value chains, there are no studies about learning economy in Iran. To our

knowledge, there are only some limited studies about knowledge based economies and the evident relations in this area. For example, Behbudi and Amiri (2010), based upon the fundamental components in knowledge based economy showed that all of these components have a positive impact on Iran's economic growth. So exploring and investigating the influencing and considerable factors for Iran's transition to learning economy is vital.

3. Information and Communication Technology and Economic Performance

Current age is the information age, the age that require having information and making relation for getting required information (Block, 2002). Hence, ICT have been recognized as a major contributor in social and economic development (OECD, 2004). Furthermore, several authors have stressed the importance of these technologies as a catalyst for growth in the current economic crisis (WEF, 2009). Economic competitiveness depends on productivity level and in the knowledge economy; ICT sectors determine the productivity level. So, we can say that the power of economic competitiveness of a country depends on the productivity of its ICT sector. As a result, ICT has become, within a very short time, one of the basic building blocks of modern society. ICT has changed social structure, living style, communicational process, and even education manner and caused to phenomenon namely information society and age named age of knowledge (Seidel, 2007). Many countries now regard understanding ICT and mastering the basic skills and concepts of ICT as part of the core of education, alongside reading, writing and numeracy. ICT permeates the business environment, it underpins the success of modern corporations, and it provides governments with an efficient infrastructure. At the same time, ICT adds value to the processes of learning, and in the organization and management of learning institutions. The application of Information technology has a great stance among basic industries since it plays an important role in different industries such as productivity, social services and job opportunity improvement (Allameh et al., 2011). After the Second World War, the government of Japan had shown great success in attracting large amount of foreign assistance and expertise to enhance economic growth. During the high growth era of 1970s and 1980s, Japanese government policies enabled the transformation of Japanese economy into a knowledge-based economy. The efforts by the government were fully paid off as Japan gradually became world's second largest economy after the U.S. The phenomenal growth of Japanese economy largely depended on the successful development of ICT. Following the similar foot step, the governments of other East Asian Economies have shown remarkable success in creating a knowledge-based economy by developing the necessary ICT infrastructure. Korea, Taiwan, Hong Kong and Singapore had been tremendously successful in the regard. Malaysia and China have also shown great success in this regard as late comers in the region. By the 1980s, many scholars (OECD, 1996) started recognizing information as a crucial factor of production along with capital and labor. Finally in the 1990s, with the rapid technological advancement ICT became one of the most critical factors for competitiveness and growth in the East Asian knowledge-based economies. During the 1990s, the availability of computers further added value to the ICT infrastructure in East Asia. Later, the wide spread use of internet and mobile phone revolutionized the ICT sector in East Asia. Today, ICT has become one of the most important sectors in furthering knowledge-based economic growth in most of the East Asian countries. Besides, ICT plays an important role in the division of regional and global value-added chain and in shifting parts of production to different geographical locations. By using ICT, the enterprises are able to exchange knowledge and information online from anywhere in the world, communicate just-in-time with clients and suppliers and deliver services efficiently and promptly. ICT, in many cases, created opportunities for businesses to be more cost effective through outsourcing and off shoring. In the East Asian knowledge-based economies, the share of ICT sector value added in total business-sector value added continues to grow (UNCTAD Information Economy database, 2007). Among the five advanced knowledge-based economies, Japan performed best. So by many scholars, ICT has been regarded as a major factor in this faster flow of technology and knowledge in the knowledge-based economies and

has a considerable effect on globalization and is a revolution in information, knowledge and organizational changes (Pavic et al, 2007). It helps companies find new ways of improving their market by providing their customers with their immediate needs (Phuong, 2008). It is playing very important role at all levels such as national, regional and global by providing the necessary connectivity among places and people. The movement of new inventions or innovations or their impacts reach the countries within very short-time which, in turn forces all the knowledge-based economies towards continuous innovations to remain competitive in the global market.

3.1. The Production of New Knowledge and the Growth of ICT

New knowledge is produced at an unprecedented pace. The growth of scientific knowledge production, supported by advances in information and computer technology, has been primarily responsible for the explosive rate of increase in knowledge. There is a widespread consensus today that contemporary Western societies are in one sense or another ruled by knowledge and expertise (Knorr-Cetina 1999). This knowledge is governed, managed, monopolized or shared throughout the industrialized countries, but also increasingly in parts of Asia. ICT is also growing fast, though at different rates. In 2001 in Northern Europe and North America between 40 to 60% of all households had internet access (OECD, 2002). In some countries, like the UK or Portugal the number of internet subscribers more than doubled between 2000 and 2001. The use of hand phones has also increased substantially worldwide, particularly in some of the Asian countries.

By considering the important role of ICT, several studies have been done about different aspects of ICT in Iran. Some researcher have studied the ICT affects on political development (Pirannejad, 2011), analysis of ICT penetration in Iran and Middle East (Gerami, 2010), socio-economic development in Iran through information and communications technology (Ebrahimian, 2003), ICT status and development strategy plan in Iran (Abbasi et al., 2008) and so on. But, different international reports showed that the state of ICT in Iran is not suitable. For example, the state of e-government is presented in the below table:

Table 2: The state of e-government in Iran (United Nations, 2012)

E-government development index value			World e-government development ranking		
2008	2010	2012	2008	2010	2012
0.4067	0.4234	0.4876	108	102	100

Besides, International Telecommunications Union (2011) has published the ICT Development Index (IDI), which compares developments in information and communication technologies (ICT) in 154 countries. Based on the latest report, Iran's ranking has decreased from 84 in 2008 to 87 in 2010. You can see this in comparison with Korea (1st rank in these years).

Table 3: The ICT Development Index (International Telecommunications Union, 2011)

Country	ICT Development Index (IDI), 2010 and 2008			
	Rank 2010	IDI 2010	Rank 2008	IDI 2008
Iran (I.R.)	87	3.39	84	2.
Korea (Rep.)	1	8.40	1	7.80

4. Methodology

This is an inductive and qualitative research by using grounded theory approach that determines the themes and related components of Iran's transition to learning economy. Grounded theory involving the discovery of theory through the analysis of data and was first presented by Glaser and Strauss

(1967). The development of grounded theory was an attempt to avoid highly abstract sociology and was part of an important growth in qualitative analysis in the 1960s and 1970s. The main impetus behind the movement was to bridge the gap between theoretically 'uninformed' empirical research and empirically 'uninformed' theory, by grounding theory in data (Goulding, 1999). Grounded theory method is a research method which operates almost in a reverse fashion from traditional social science research. Rather than beginning with a hypothesis, the first step is data collection, through a variety of methods. From the data collected, the key points are marked with a series of codes, which are extracted from the text. The codes are grouped into similar concepts in order to make them more workable. From these concepts, categories are formed, which are the basis for the creation of a theory, or a reverse engineered hypothesis. This contradicts the traditional model of research, where the researcher chooses a theoretical framework, and only then applies this model to the phenomenon to be studied (Allan, 2003). The theory evolves during the research process itself and is a product of continuous interplay between data collection and analysis of that data. Consequently, unlike many other methods, the grounded theorist does not wait until all the data is collected before analysis begins; rather, the search for meaning through the interrogation of data commences in the early stages of data collection (Strauss & Corbin, 1990). Given its emphasis on new discoveries, the method is usually used to generate theory in areas where little is already known, or to provide a fresh slant on existing knowledge about a particular social phenomenon. Initially the process starts with an interest in an area one wishes to explore further. Consequently, the researcher's mission is to build his/her own theory from the ground. Unlike other qualitative methodologies which acknowledge only one source of data, for example the words of those under study as in the case of phenomenology, grounded theory research may be based upon single or multiple sources of data. These might include interviews, observations, focus groups, life histories, and introspective accounts of experiences. This exploratory research is drawn from qualitative data collected in interviews and other data sources over the last 2 years in Iran through 1) After a number of pilot and open interviews, we carried out a round of 29 supplemental semi structured interviews with 16 key academicians chosen for their experience of working across a range of related fields, both in the industry and government sector to provide insights from different perspectives to collect data and 2) Complementary qualitative data gathered simultaneously through deep and comprehensive data gathering. Briefly, multiple sources of data are embraced and engaged in a recursive process that used for establishing a chain of evidence as follow:

1) The guidelines presented by superior leader of Iran
2) Iran's 1404 development vision
3) Iran's holistic scientific map
4) Iran's 5th development plan
5) Iran's Comprehensive IT Strategic plan
6) Reports and publications of international organizations such as World Bank, IMF, OECD, United Nations about Iran
7) Published books and articles in Persian and other languages about Iran development issues
8) Academic resources such as related thesis's
9) Opinions of policy makers, managers and other important decision makers that published through different mediums

5. Data Analysis

In this research, data analysis and collection interacted during the research process according to principles of grounded theory approach. Data analysis was facilitated by computer aided qualitative data analysis (CAQDAS) – ATLAS.ti. version 5 that is a powerful workbench for the qualitative analysis of large bodies of textual, graphical, audio, and video data. It offers a variety of tools for accomplishing the tasks associated with any systematic approach to unstructured data, e.g., data that cannot be meaningfully analyzed by formal, statistical approaches. In the course of such a qualitative

analysis, ATLAS.ti helps us to explore the complex phenomena hidden in the data. There are two principal modes of working with ATLAS.ti, the Textual Level and the Conceptual Level. The Textual Level includes activities like segmentation of data files; coding text, image, audio, and video passages; and writing memos. The Conceptual Level focuses on model-building activities such as linking codes to networks. A third and equally important aspect is the management of projects and the data. As a sample, a part of software output is as follow:

Figure 1: A sample of the ATLAS.ti output
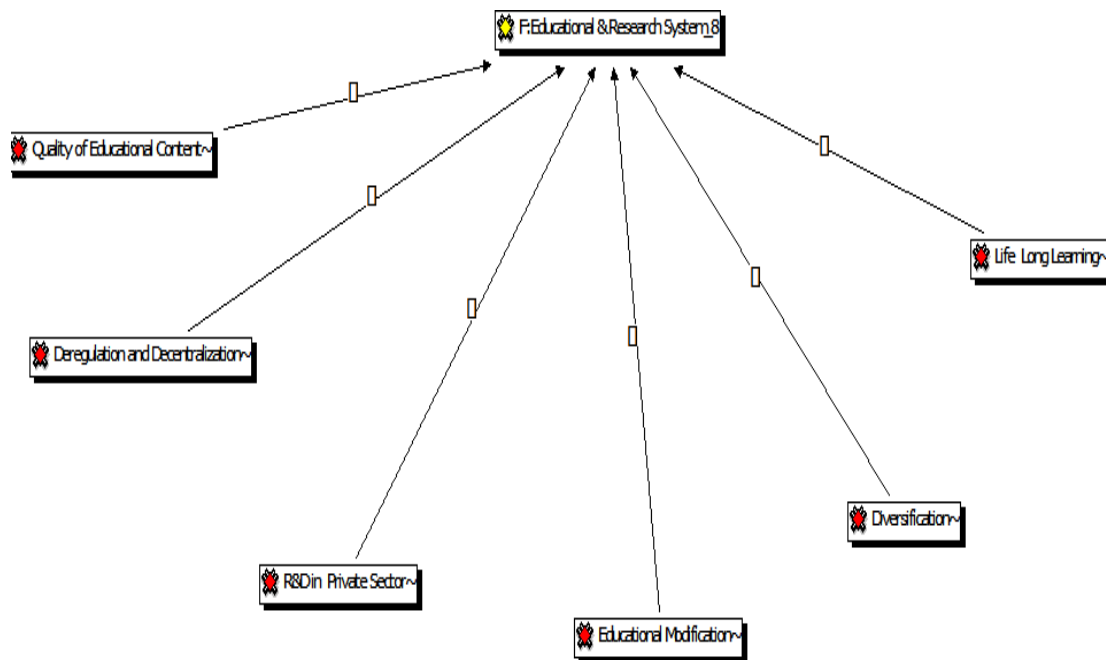
In this stage, 3337 codes and 600 memos generated that result in 11 categories (themes), 100 concepts (components) and 3337 codes.

Table 4: Iran's transition to learning economy ((11 categories (themes), 100 concepts (components) and 3337 codes)) at a glance

Categories	Number of Concepts	Number of codes
Institutions	7	182
GIU Interactions	9	257
Learning firms	16	472
Macro Economic Conditions	10	418
Information and communication technology	3	141
Regional development	10	371
Social Capital	5	210
Improved Research and Education system	18	569
Collaborative learning	4	144
Policy institution	10	316
Transitional thinking	8	229

As we can see in the table, "information and communication technology" is one of the important themes that can be considered as an intervening condition in the transition. Elimination of digital divide between regions and at national level, ICT's Infrastructure development and E-Government development are the related important components that should be consider in Iran as will be described below.

5.1. Elimination of Digital Divide between Regions and at National Level

The attention given by leaders from all over the world to the concept of information society and the potential for a digital divide has risen significantly in recent years (Cruz-Jesus et al., 2012). According to the OECD, less than 0.1 in every 100 people have access to a computer in developing countries, whereas in the developed world the corresponding proportion is 60 in every 100 people (OECD, 2009). This ratio represents a "digital divide", which refers to the ICT inequality among countries, in terms of ICT investments, PC skills, Internet skills and the availability of telecommunications networks. The digital divide is commonly related to the economic status of a country (Fuchs, 2009) since ICT services and products seem to be channeled more effectively in wealthy countries. However, poor countries could benefit from new technologies by exploring opportunities related to general development (Kyriakidou et al., 2011), so the digital divide refers to the uneven distribution of information and communication technology (ICT) between and within nations. It reflects differences among and within countries" (OECD, 2002) and was established as a term in 1990s, in order to describe the perceived growing gap between those who have access to and the skills to use ICT and those who have limited or no access at all (Jeffrey, 2003). Access to telephones appears to be the basic factor, because internet use per telephone subscriber does not differ very much between countries (Dasgupta and Lall et al., 2001). In general the concept "digital divide" is biased towards high technology and need to be re conceptualized to pay greater attention to social exclusion and inclusion (Warschauer, 2003). In each country there are people who have access to modern communication technology while others are not enabled to make use of telephone connections, the internet and other ICT features. There is no doubt that such a digital divide exists but its severity and depth is evaluated differently according to the indicators used to measure it. The knowledge gap is a more complex phenomenon and refers to the uneven intensity of knowledge production, availability and dissemination worldwide. There appears to be a connection between the two: The digital divide determines to a large extent the capacity of producing and using new knowledge. Overcoming the digital divide and narrowing the knowledge gap between and within countries has become a prime target of international development agencies as well as of some national governments. Components of the information and communication technology (ICT) infrastructure and of institutions of knowledge production and dissemination are, however, unevenly distributed. In the year 2000 in the United States about a third of the work force was employed in ICT related sectors, in Korea only 4% or about half a million workers and much less in most of East and Southeast Asia. About 30% of R&D expenditure worldwide is spent in the European Union, Asia and the United States respectively, a small proportion in the rest of the world (UNESCO, 2000). The result is a widening digital divide, which mirrors the income differences between developed and underdeveloped economies (World Bank, 1999). There are nodal points where digital equipment is concentrated, where knowledge is produced and from where it is globally distributed. Research on Indonesia, for example, may be extensively done by foreign scholars, affiliated to universities or research institutions around the globe, rather than Indonesian nationals or scholars attached to its local institutions (Evers 2003). This raises the issue of how far knowledge is produced to meet local needs rather than the interests of a global community of scholars or the R&D interests of multi-national corporations. The unequal production and distribution of knowledge is widening the knowledge gap between highly productive and less productive countries. The distribution of ICT and the production of knowledge are interrelated, but the exact nature of this connection is far from clear. An ICT infrastructure can only be developed if the necessary scientific knowledge and expertise is locally available. The production of new knowledge is, however, not primarily dependent on the availability of ICT, though being on the wrong side of a digital divide reduces the chances for innovative knowledge production. The debate about the impact of the digital divide on development has given rise to diametrically opposed views. "Some believe that information and communication technologies (ICT) can be mechanisms enabling developing countries to 'leapfrog' stages of development. Others see the emerging global information infrastructure as contributing to even wider economic divergence between

developing and industrialized countries" (Braga, 1998). In any case, closing the digital divide and the knowledge gap are regarded as necessary steps towards economic development. Knowledge is the most important factor of production and its growth is essential to propel a country into self-sustained growth. Development agencies like the World Bank have been the outspoken proponents of the gap-closing strategy. Singapore and Malaysia have taken the lead in arguing the case in Southeast Asia and other ASEAN nations, like Thailand and Vietnam are following.

There is a large consensus on the existence of different types of divides related to the diffusion and use of ICT (OECD, 2002). One can identify an international divide between developed and developing countries; a geographical divide between major cities and rural areas which are far less likely to have Internet, phone, and PC access; and other divides arising from differences in income, education, age, gender, language and many others. The divide exists within Iran, for instance between urban and rural areas, between men and women, between the educated and the unschooled or between the young and the elderly. It is a result of socio-economic disparities and thus little different from other income, health and education divides. The root cause of these disparities is poverty. The less money a country's citizens have, the less likely they are to use ICTs. The Internet is of little use to people who are not able to exploit electronic access to information to improve their lives. Access to information is a measure of power in society, and thus the digital divide reflects how power is distributed. Among the main measures to be taken in order to bridge the digital divide in Iran for transition to learning economy, the main one is certainly to build, strengthen and continuously improve and maintain the public infrastructure of knowledge, allowing each citizen to have equal access to public knowledge. This goal has two facets: the first one is in terms of content. Public bodies must ensure the quality and quantity of public knowledge that flows and can circulate on the Internet, in particular, in the language understood by local populations. The second one is to provide the best conditions of public access to the infrastructures that distribute knowledge. Public policy could thus facilitate the 'distributive power of knowledge' by encouraging the development of modern information infrastructures such as linking public libraries, developing e-learning and tele-education, implementing e-government procedures with uniform protocols and format standards, along with providing opportunities for citizens to easily access these common infrastructures of knowledge.

ICTs and regional settings have significantly contributed to the internal dissemination of information and knowledge. What might be different in this period is the extreme rate of change in certain areas related to the production and use of ICT and the breadth of the impact across regions. However, it is not a substitute for the tacit knowledge that is required in modern industries. It is important to note that the nature of the costs of digital divide is quite different for those leading and pushing the process of change and those lagging behind. This is true for people as well as regions. This has been a structural challenge for transition to learning economy involving, however, some regions much more than others. Although data are scarce on many factors of potential relevance for regional growth, the evidence clearly indicates that most low-income regions in Iran have failed to exploit the potential for information technology diffusion. This point to a need for policies aimed at enhancing the capacity of such regions to absorb new technologies, especially ICTs and implies that the nature and embeddedness of ICTs' services within national or regional systems of innovation will be a key factor for long-term national economic performance.

5.2. ICT's Infrastructure Development

Building an effective national information infrastructure (NII) has become a high priority to governments around the world, so there must be affordable and equitable access and connectivity to ensure that all levels of society can participate in the new economy. Just as the telecommunications infrastructure provides the transport means for the information economy to develop, creating the infrastructure for information itself is becoming a key agenda, at national, regional and global levels. For example, the usage of broadband services is connected to the economic growth and the level of

broadband coverage has become one of the main characteristics of a developed country (Horrigan, 2009). As the government initiative forms the foundations in creating an information infrastructure, governments initiate projects to improve telecommunications infrastructures and to construct new channels that are more advanced and accessible. Such projects include Singapore's Intelligent Island, Malaysia's the Multimedia Super Corridor 2020, United States' the Global/National Information Infrastructure, and Canada's the Information Highway. These NIIs are being designed to create an "electronic city" to link homes, schools, libraries, hospitals, and small businesses to this information superhighway. Just as electricity, streets, and water are core infrastructures that serve residents, businesses, and government alike, so too is the information infrastructure a community-wide need, such as education, human resources, health care, and public services (Shin, 2007). Businesses and citizens must have access to a low-cost, high-speed communication infrastructure. This is a key to balanced urban and regional development across the country. Reducing access costs plays a major role in this context. In terms of accessibility to the IT infrastructure, Iran performed better compared to other developing countries, but the situation reversed when compared with advanced countries. As a result of heavy investment in the telecommunication system in Iran since 1995, the number of telephone lines, cellular phone, and radio and television stations has grown rapidly. Many cities have been brought into the net. It should be considered that the statistics in this field change every day. But Iran needs to base its national information and communication technology strategy on a much greater consideration of local cultural and social issues (Abbasi et al., 2008). we argued that the vital importance of ICT infrastructure to Iran's national interest, the failure of market forces alone to ensure universal access to broadband technology, and the historical precedent set by large scale public infrastructure during the industrial era invite consideration of the desirability and feasibility of governments and/or communities developing, controlling and maintaining advanced ICT infrastructure as a form of public infrastructure. The ICT infrastructure represents a basis for the development of the academic institution. The basic potentials and constraints for the infrastructural development of the needed institutions for transition to learning economy are determined by its status and its relationship with other institutions such as government institutions and various parts of the society.

5.3. E-government Development

As the scope of government responsibilities increases, so does its costs, increasing the tax burden on the citizen. In an environment that requires employees to provide results seven days a week, twenty-four hours a day, citizens want a government that provides services and information to them on the same basis. Previously, the government could make itself available to citizens during the traditional forty-hour workweek, but this is no longer acceptable. Citizens themselves must be at work and do not want to take time away from their jobs to wait in long inefficient lines to obtain government services. In order to cost effectively deliver the increasing number of services, the government is required to provide, services must be increased while costs must be reduced. One of the greatest opportunities to accomplish this is by increasing the efficiency of the delivery of these services to the citizen by using electronic services. Given that 60 percent of all current Internet users interact with government Web sites; this is a logical way to reduce costs (Evans and Yen, 2006). ICT enabled information networks (e.g. LANs, Intranets, Internet) increasingly remove the boundaries separating internal parts of the government from each other (improving efficiency) and from users (improving effectiveness) (Gary et al., 2003). As a result, the use of information and communication technologies (ICTs) in government has significantly increased in the last few decades. Countries around the world are now adopting strategies for better use of these technologies with very different objectives: greater efficiency, deeper transparency, higher service quality, and more engaged citizen participation. What is now called "electronic government" has become a powerful strategy for administrative reform at all levels of government. The concept of e-government is commonly understood as governmental procedures and tasks supported by (ICT enabled) digital means: e-government is the use of information and

communication technologies to improve the activities of public sector organizations. Simply speaking, E-Government means the communication between the government and its citizens via computers and a Web-enabled presence. The advantages in timeliness, responsiveness, and cost containment are outstanding (Evans and Yen, 2006). For purposes of analysis, we propose to decompose government procedures and tasks in two components (Jaro, 2004):

1. I-government: converting existing information processes and paper objects into digital form. This first step focuses on the internal digitalization of documents, and contributes to the efficiency and effectiveness of public administration.
2. E-government: upgrading and building on previous step of i-government, it relates to Internet-based digital services offered by the government administration to its nongovernment clients (i.e. citizens and businesses). E-Government is converting literal services into virtual services.

E-Government started as a practice-driven field (Gronlund and Horan, 2004) which tended to be optimistic about the outlook for a fully-integrated information society. In many cases, digital divide issues should be considered as important components in E-Government theoretical models, either as affecting the demand of E-Government services, limiting the usefulness of certain government applications, or assessing the social desirability of information technologies in certain policy domains (Helbig et al., 2009). E-Government readiness varies significantly across nations (UN, 2008). A nation's e-Government readiness depends on factors such as the availability of economic, human, and technological resources, a government's willingness and/or interest in understanding and catering to the needs of the people, the sufficiency of infrastructure and adequacy of services delivery, content accessibility, usefulness and accuracy of digital information and e-Services, languages, trust, and confidentiality (UN, 2008; Holliday and Yep, 2005). There are many obstacles to successful E-Government implementation, including financial, planning, political objectives, and lack of citizen acceptance and/or interest. A UN study divides these obstacles into the following categories: institutional weakness, human resources, funding arrangements, local environment, and technology issues (United Nations Division for Public Economics and Public Administration, 2002).

Coordination between different actors in a nation-state is a critical element for increasing collaboration that is important in transition to learning economy. In the past, coordination between governments has been poor but it is hoped that E-Government applications will improve coordination. Regional development is more clearly taking advantage of the potential benefits of new and emergent information technologies for improving coordination. So, two key issues facing the implementation of electronic government at all levels of government are collaboration and coordination (Sandoval-Almazan and Gil-Garcia, 2012). Both of them are critical elements for transition to learning economy. On the other hand, some concepts such as e-learning and distance learning can be facilitated through the e-government services at different level. So, Iran needs to a well developed ICT infrastructure for transition to learning economy.

6. Conclusion

In this research, we have investigated the strategic influences of information and communication technology on Iran's transition to learning economy. In this stage, 3337 codes and 600 memos generated that result in 11 categories (themes), 100 concepts (components) and 3337 codes. Elimination of digital divide between regions and at national level, ICT's Infrastructure development and E-Government development are the related important components that should be consider in Iran. As a result, flexibility due to an IT infrastructure (ITI) is considered an important source of business value. Business, public, and governmental organizations confronted with time and other pressures must adjust their strategies, but frequent change cannot be accomplished unless the ITI is able to accommodate it in an efficient and effective manner (Fink and Neumann, 2009). However, Iran currently lacks some of the critical elements to support the learning economy. Among them are the lack of adequate knowledge

and skilled human resources, inadequacy of a learning economy supportive education and training infrastructure, a relatively weak ICT infrastructure for science and technology, a deficiency in institutional support and info structure and a slowly evolving financing system.

References

[1]   Abbasi, A., Sadeghi Niaraki, A., and Mirzaeian Dehkordi, B., 2008. "A review of ICT status and development strategy plan in Iran", *International Journal of Education and Development using Information and Communication Technology*, Vol. 4, Issue 3, pp. 143-154.

[2]   Allameh, S.M., Z., Momeni, Z., Shekarchizadeh, and M., Esfahani, 2011. "An assessment of the Effect of Information Communication Technology on Human Resource Productivity of Mobarekeh Steel Complex in Isfahan (IRAN)", *Procedia Computer Science*, 3, 1321–1326.

[3]   Allan, G., 2003. "A critique of using grounded theory as a research method", *Electronic Journal of Business Research Methods*, 2 (1)1-10.

[4]   Asheim, B.T., and L. Coenen, 2006. "Contextualising Regional Innovation Systems in a Globalising Learning Economy: *On Knowledge Bases and Institutional Frameworks", Journal of Technology Transfer*, 31,163–173.

[5]   Behbudi, D., and B. Amiri, 2010. "The Long Run Relationship between Knowledge Based Economy and Economic Growth in Iran", *Journal of Science and Technology Policy*, 2 (4) 23-33 (In Persian).

[6]   Block, H.D., R., Ostam, M.E., otter, and M, Overment, 2002. "Computer assisted instruction in support of beginning reading instruction", *A review of education research*, 73(1), 101-130.

[7]   Braga,   C.   A.   P.,   1998.   "Inclusion   or   Exclusion",   http: / /www.unesco.org/courier/1998_12/uk/dos sier/ txt21.htm.

[8]   Bruton, G.D., D. Ahlstrom, and K. Obloj, 2008. "Entrepreneurship in emerging economies: where are we today and where should the research go in the future", *Entrepreneurship Theory and Practice*, 32 (1) 2–14.

[9]   Cappellin, R., 2007. "The Territorial Dimension of the Knowledge Economy: Collective Learning, Spatial Changes, and Regional and Urban Policies", *American Behavioral Scientist*, 50: 897.

[10]   Carayannis, E.G, D. Popescu, C. Sipp, and M. Stewart, 2006. "Technological learning for entrepreneurial development (TL4ED) in the knowledge economy (KE): Case studies and lessons learned", *Technovation*, 26,419–443.

[11]   Dasgupta, S., and S. V. Lall, et al., 2001. "Policy Reform, Economic Growth, and the Digital Divide:An Econometric Analysis", Wasington, D.C., *World Bank Working Paper* No. 2567.

[12]   Ebrahimian, L.D., 2003. "Socio-Economic Development in Iran through Information and Communications Technology", *Middle East Journal*, Vol. 57, No. 1 (Winter), pp. 93-111.s.

[13]   Edquist, Ch., 1997. "Systems of innovation approaches—their emergence and characteristics", In: Edquist, Ch. (Ed.), *Systems of Innovation: Technologies, Institutions and Organisations*, Pinter, Canada.

[14]   Evans, D., D.C., Yen, 2006. "E-Government: Evolving relationship of citizens and government, domestic, and international development", *Government Information Quarterly*, 23, 207–235.

[15]   Evers, H.-D, 1999. "Crisis and Beyond: Theorizing Southeast Asia", *4th ASEAN Inter-University Seminar on Social Development*, 15-18 June 1999, Prince of Songkla University, Pattani.

[16]   Fakour, B., and H. Haji Hosseini, 2008. "Academic Entrepreneurship and commercialization of research results in Iranian universities (Case study of seven Iranian universities)", *Journal of Science and Technology Policy*, 1 (2)59-71 (In Persian).

[17]   Fink, L., and S. Neumann, 2009. "Exploring the perceived business value of the flexibility enabled by information technology infrastructure", *Information & Management*, 46, 90–99.

[18]   Fuchs, C., 2009. "The roles of income inequality in a multivariate cross national analysis of the digital divide", *Social Science Computer Review*, 27:41–58.

[19]   Gary, M., S., Hanan, and Larry, B., 2003. "Digital Government", *Communication of the ACM*, (Vol. 46, No. 1.), January, p. 25-27.

[20]   Gerami, M., 2010. "Analysis of ICT Penetration in Iran and Middle East", *Second International Conference on Computer and Network Technology*, Bangkok, Thailand, April 23-April 25.

[21]   Ghaneirad, M., A. Toloo, and F. Khosrokhavar, 2008. "Factors, Motives and Challenges of Knowledge Production among Scientific Elites", *Journal of Science and Technology Policy*, 1 (2)71-86 (In Persian).

[22]   Glaser, B., and A., Strauss, 1967. "The Discovery of Grounded Theory: Strategies for Qualitative Research", Chicago: Aldine.

[23]   Goulding, C., 1999. "Grounded Theory: some reflections on paradigm, procedures and misconceptions", *Wolverhampton Business School, Management Research Centre*, UK.

[24]   Gronlund, Å., and T.A., Horan, 2004. "Introducing e-Gov: History, definitions, and Issues", *Communications of the Association of Information Systems*, Vol. 15, 713?729.

[25]   Hajihoseini, H., F. Abbasi, M. Mohammadi, and M. Elyasi, 2011, "Analysis of Iranian Innovation System's Governance Based on Innovation Policy Making Cycle", *Journal of Science and Technology Policy*, 4 (1), 33-49 (In Persian).

[26]   Helbig, N., J. R., Gil-García, and E. Ferro, 2009. "Understanding the complexity of electronic government: Implications from the digital divide literature", *Government Information Quarterly*, 26, 89–97s.

[27]   Holliday, I., and R., Yep, 2005. "E-Government in China". *Public Administration and Development*, 25(3), 239–249.

[28]   Hsu, G.J.Y., 2001. "Knowledge-based economies and competition policy: developmental strategy concerning the liberalization and internationalization of Taiwan's business", *Fair Trade Quarterly*, 4 (9)123–136.

[29]   Hsu, G.J.Y., Y. Lin, and Z. Wei, 2008. "Competition policy for technological innovation in an era of knowledge-based economy", *Knowledge-Based Systems*, 21.826–832.

[30]   Hyysalo, S., 2009. "Learning for learning economy and social learning", *Research Policy*, 38, 726–735.

[31]   Jaro, B, 2004. "The influence of Information Society Technologies on Evolution in the Public Administration", Merkur Day 2004, *6th Undergraduate and Graduate Students eCommerce Conference & 8th Executive Business, Government, and University Meeting on Cross-border eInvoice in eRegion, Organized by Faculty of Organizational Sience, University of Maribor* (ISBN 961-232-171-X, CIP 659.2.004(063) (086.2.034) - cd-rom and published on Internet page: http://ecom.fov.unimb. si/MerkurDay2004/program.htm), Naklo October 22.

[32]   Jeffrey, J., 2003. "Bridging the global digital divides", Northampton: Edward Elgar.

[33]   Johnson, B. , 1992. "Institutional learning", In: Lundvall, B.A. (Ed.), *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers, London, UK.

[34]   Khodadad Hosseini, S., P. Riahi, and M. Nouri, 2012. "Promotion of Innovation in Developing Countries: Study of Economic Development Plans of Iran", *Journal of Science and Technology Policy*,4 (3)101-116 (In Persian).

[35]   Knorr-Cetina, K., 1999. "Epistemic Cultures: How the Sciences Make Knowledge". *Cambridge, Harvard University Press*.

[36]   Kyriakidou, V., Michalakelis, C., and Sphicopoulos, T., "Digital divide gap convergence in Europe", *Technology in Society*, 33, 265–270.

[37]   Lam, A., 2000. "Tacit Knowledge, Organizational Learning and Societal Institutions: An Integrated Framework", *Organization Studies*, 21 (3)487–513.

[38] Lundvall, B.A., 1992. "National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning", *Pinter Publishers*, London, UK.

[39] Lundvall, B.A., 1999. "Nation states, social capital and economic development a system's approach to knowledge creation and learning", *SUDESCA conference*, San Jose, Costa Rica.

[40] Lundvall, B.A., and B., Johnson, 1994. "The Learning Economy", *Journal of Industry Studies*, 1(2) 23-42.

[41] Lundvall, B.A., and S., Borrás, 1998. "The Globalising Learning Economy: Implications for Innovation Policy", *Brussels: European Commission*.

[42] Lundvall, B.A., P. Intarakumnerd, and J. Vang, 2006. "Asia's Innovation Systems in Transition", *Edward Elgar Publishing*, Inc.

[43] Lundvall, B.A., P., Rasmussen, and E. Lorenz, 2008. "Education in the Learning Economy: A European perspective", *Policy Futures in Education*, 6 (6).

[44] Mathews, J.A., 2001. "National systems of economic learning: the case of technology diffusion management in East Asia", *International of Technology Management*, 22 (5/6)455–479.

[45] Mu, J., F. Tang, and D. L. Mac Lachlan, 2010. "Absorptive and disseminative capacity: Knowledge transfer in intra-organization networks", *Expert Systems with Applications*, 37-, 1–38.

[46] National Research Institute for Science Policy, 2008. "The strategic change plan for Islamic Republic of Iran's science and technology, investigating and evaluation of current and desired situation and analysis of science and technology gap and comparative study with selected countries (Turkey, Japan, United States of America, United Kingdom, India, Pakistan, Malaysia)", Tehran: *National Research Institute for Science Policy publications,* (In Persian).

[47] OECD, 1996. "The Knoledge-based Economy", *OECD*, Paris.

[48] OECD, 2000. "Knowledge Management in the Learning Society", Paris: *OECD*.

[49] OECD, 2002. Measuring the Information Economy". Paris, *OECD*: www.oecd.org/s ti /me asuring- infoeconomy.

[50] OECD, 2004. "The economic impact of ICT: Measurement, evidence and implications, Paris: *Organization for Economic Cooperation and Development*.

[51] OECD, 2009. "Organization for economic, co-operation and development", Available: www.oecd.org/; 2009.

[52] Pavic, S., S.C.L., Koh, M. Simpson, and J. Padmore, , 2007. "Could e-business create a competitive advantage in UK SMEs?", *Benchmarking: An International Journal*, , Vol. 14 No. 3, pp. 320-51.

[53] Paya, A., 2008. "Public Understanding of Science: A Philosophical Appraisal*", Journal of Science and Technology Policy*, 1 (1) 25-38 (In Persian).

[54] Perez, C., 1996. "New technologies and socio-institutional change", Paper presented at the International Conference on Long Wave Theory and its Practical Applications, *Lindenthal Institute, Cologne, September*.

[55] Phuong, Th., 2008. "Internet use, Custonmer Relationships' and loyalty in the Vietnamese travel in industry", *Asia pacific journal of marketing and logistics*, Vol. 20, Pp. 190-210.

[56] Pirannejad, A., 2011. "The effect of ICT on political development: a qualitative study of Iran", *Information Development*, August, vol. 27 no. 3 186-195v.

[57] Qu, Z., C., Huang, Zhang, M., and Zhaod, Y., 2013. "R&D offshoring, technology learning and R&D efforts of host country firms in emerging economies", *Research Policy*, 42, 502– 516.

[58] Regional Information Center for Science and Technology, 2012. "Science and Technology report", *Regional Information Center for Science and Technology publications*, available online at http://www.srlst.com.

[59] International Telecommunications Union, 2011. "The ICT Development Index", *International Telecommunications Union Publications*, Available online in www.itu.int/net/pressoffice/backgrounders/general/pdf/5.pdf.

[60] Sandoval-Almazan, Rodrigo, and J.R. Gil-Garcia, "Are government internet portals evolving towards more interaction, participation, and collaboration? Revisiting the rhetoric of e-government among municipalities", *Government Information Quarterly*, 29, S72–S81.

[61] Seidel , T ., and R.J. shavelson, 2007. "Teaching effectiveness in the past decade: the role of theory and research in disentangling meta- analysis in results", *Review of educational research*, 77(4), 454-499.

[62] Shin, D., 2007. "A critique of Korean National Information Strategy: Case of national information infrastructures", *Government Information Quarterly*, 24, 624–645.

[63] Smith, K., 2000. "What is 'The Knowledge Economy'? Knowledge- Intensive Industries and Distributed Knowledge Bases", *Paper presented at the DRUID Summer Conference on 'The Learning Economy – Firms, Regions and Nation Specific Institutions*, Aalborg, Denmark, June.

[64] Strauss, A., and J., Corbin, 1990. "Basics of Qualitative Research: grounded theory procedures and techniques", *London*: *Sage*.

[65] Supreme Cultural Revolution Council, 2003. "The council for scientific and cultural monitoring and evaluation, Science and technology evaluation in Islamic Republic of Iran", (1st macro evaluation), *Tehran: Supreme Cultural Revolution Council publications*, (In Persian).

[66] UN, 2008. "United Nations E-Government survey 2008: From e-Government to connected Governance". *New York: Author*.

[67] UNCTAD, 2007. "Science and technology for development: the new paradigm of ICT", *Information Economy Report* 2007-2008, New York and Geneva.

[68] UNESCO, 2000. "Facts and Figures", Paris, *UNESCO Institute for Statistics*.

[69] United Nations Division for Public Economics and Public Administration, 2002. "Benchmarking E-Government: A global perspective, assessing the progress of the UN member states", *Retrieved on September 8, 2002*, from http://unpan1.un.org/intradoc/groups/public/documents/un/unpan003984.pdf.

[70] United Nations, 2012. "United Nations E-Government Survey", *United Nations publications*, Available online in http://www.unpan.org/egovkb/global_reports/08report.htm.

[71] Warschauer, M., 2003. "Technology and Social Inclusion. Rethinking the Digital Divide", *Cambridge, Mass*., MIT Press.

[72] WEF, 2009. "The global information technology report 2008–2009, WEF, *Retrieved from /http://www.wef.comS*.

[73] World Bank, 1999. "World Development Report 1998-99: Knowledge for Development", *New York, Oxford University Press*.

[74] World Bank, 2012. "Knowledge Appraisal Measurement", *World Bank Publications*, Washington D.C.

Application des Réseaux de Neurones Artificiels de Type PMC Pour la Prédiction des Teneurs en Carbone Organique dans Les Dépôts du Quaternaire Terminal de la Mer d'Alboran

Abdellah EL Hmaidi
Université Moulay Ismail, Faculté des Sciences de Meknès
Département de Géologie, Equipe Sciences de l'Eau et Ingénierie de l'Environnement
B.P. 11201, Zitoune, Meknès, Maroc
E-mail: elhmaidi@yahoo.fr

Hicham EL Badaoui
Université Moulay Ismail, Faculté des Sciences, Département de Chimie
Equipe Chimie Analytique et Environnement, B.P. 11201, Zitoune, Meknès, Maroc
E-mail: elbadaoui.hicham@gmail.com

Abdelaziz Abdallaoui
Université Moulay Ismail, Faculté des Sciences
Département de Chimie, Equipe Chimie Analytique et Environnement
B.P. 11201, Zitoune, Meknès, Maroc
E-mail: a.abdallaoui@gmail.com

Bouchta EL Moumni
Université Abdelmalek Essaadi, Faculté Polydisciplinaire de Larache
B.P: 745, Poste Principale, 92004, Route de Rabat, Km 2 – Larache, Maroc
E-mail: bmoumni@yahoo.fr

Résumé

La mer d'Alboran constitue la partie située à l'extrême ouest de la mer Méditerranée. Elle est comprise entre l'Espagne au nord, l'Algérie et le Maroc au sud et le détroit de Gibraltar à l'ouest. Elle appartient à la chaine bético-rifaine et représente un point d'échange à travers le détroit de Gibraltar entre l'océan atlantique à l'Ouest et le bassin algéro-baléare à l'Est.

Le présent travail porte sur la prédiction des teneurs en carbone organique dans les dépôts du Quaternaire terminal de la mer d'Alboran, en utilisant deux outils de modélisation : la régression linéaire multiple et les réseaux de neurones artificiels de type Perceptron Multicouches (PMC). Ces derniers ont été effectués avec le langage Matlab qui représente un réseau multicouche non récurent en se basant sur un apprentissage supervisé et un algorithme de levenberg Marquardt.

Les résultats obtenus aboutissent à modéliser avec performance les relations entre le carbone organique et les autres paramètres environnementaux dans chacune des bases de données analysées et par conséquent de prédire les teneurs en carbone organique dans les dépôts du Pléistocène – Holocène de la mer d'Alboran.

Mots clés: SIG, Réseaux de neurones, régression linéaire multiple, prédiction, carbone organique, carottes Kullenberg, Pléistocène, Holocène, mer d'Alboran.

Abstract

The Alboran basin is included in the Rif Betico chain and represents a point of exchange through the Strait of Gibraltar between the Atlantic Ocean to the west and the Algerian-Balearic Basin in the east.

This work focuses on predicting the organic carbon content in the terminal Quaternary deposits of the Alboran Sea, using two modeling tools: multiple linear regression and artificial neural networks the type Multilayer Perceptron (MLP). The latter were performed with the langage Matlab, representing a multi-layer non-recurring based on a supervised learning and a Levenberg Marquardt.

The results lead to model with great performance relationships between organic carbon content and those of other environmental parameters in each of the databases analyzed, and therefore to predict organic carbon content in the deposits of the Pleistocene - Holocene Basin Alboran.

Keywords: GIS, Neural Networks, Multiple linear regression, prediction, organic carbon, Kullenberg cores, Pleistocene, Holocene, Alboran basin.

1. Introduction

Le présent travail porte sur une étude comparative des modèles de prédiction des teneurs en carbone organique dans les dépôts du Quaternaire terminal de la mer d'Alboran, en utilisant la régression linéaire multiple et les réseaux de neurones artificiels.

Les réseaux de neurones ont trouvé un grand succès dans la simulation et la prévision des paramètres environnementaux. En effet, Perez et al. (2001) ont proposé de prévoir la concentration de NO_2 et de l'oxyde nitrique NO à Santiago en se basant sur les variables environnementaux et en utilisant la méthode de régression linéaire et la méthode des réseaux de neurones. Un autre exemple d'application de ces réseaux est la prédiction des concentrations des métaux lourds dans les sédiments fluviaux marocains, à partir d'un certain nombre de paramètres physico-chimiques (Abdallaoui et al., 2011). De la même manière, nous tentons dans cette étude d'utiliser les réseaux de neurones pour l'élaboration de modèles mathématiques stochastiques pour la prédiction des teneurs en carbone organique dans les dépôts du Quaternaire terminal de la mer d'Alboran.

Les données utilisées proviennent des travaux antérieurs réalisés dans la mer d'Alboran (El Moumni, 1994, Hassouni, 1997, El Hmaidi, 1999, El Moumni et al., 2000). Elles comportent l'ensemble des paramètres sédimentologiques, minéralogiques et géochimiques des dépôts recoupés par sept carottages Kullenberg.

La méthodologie adoptée repose d'abord sur la mise en évidence de quatre bases de données en fonction de leur âge respectif, Pléistocène supérieur, Holocène inférieur, Holocène supérieur et la quatrième base comporte l'ensemble des données allant depuis le Pléistocène supérieur jusqu'à l'Actuel. Ensuite, chaque base de données est traitée à part pour dégager les modèles de prédiction des teneurs en carbone organique (Zahid, 2011, El Hmaidi et al., 2011).

Les résultats attendus devraient aboutir à des équations et modèles qui précisent les relations entre les teneurs en carbone organique et les autres paramètres environnementaux dans chacune des bases de données analysées et par conséquent de modéliser et de prédire ces teneurs en carbone organique dans les dépôts du Pléistocène – Holocène du bassin d'Alboran.

2. Description de la Zone D'étude

La mer d'Alboran, inscrite à l'intérieur de la chaîne bético-rifo-tellienne, occupe une zone privilégiée à la terminaison occidentale des chaînes alpines méditerranéennes. C'est un bassin de dimension modeste avec 165km de large et 350km de long. Elle représente la seule communication de la Méditerranée avec l'océan mondial depuis la fin du Miocène, date de l'ouverture du détroit de Gibraltar.

La structure morphologique la plus apparente est constituée par la ride d'Alboran qui subdivise cette partie de la Méditerranée occidentale en trois domaines morphostruturaux différents représentés par le bassin occidental d'Alboran, le bassin sud d'Alboran et le basin oriental d'Alboran. De part et d'autre du détroit de Gibraltar, les bordures continentales méridionale (Rif au sud) et septentrionale (cordillères Bétiques au nord) font partie de la chaine alpine avec un socle paléozoïque, surmonté par une série sédimentaire secondaire et tertiaire affectée par des plissements tertiaires. En s'éloignant de la mer et de façon symétrique à la mer d'Alboran, trois domaines structuraux se distinguent avec un domaine interne, un domaine de flysch et un domaine externe (Fig. 1).

Le climat, de type méditerranéen, se caractérise par une saison chaude et sèche (de juin à novembre) et une saison froide et humide (de décembre à avril). En allant de l'ouest vers l'est et du nord vers le sud, le gradient de précipitations diminue. Les vents sont fréquents, relativement forts et proviennent en générale de l'ouest à sud- ouest en hiver et de l'est à nord-est en été (Tesson, 1977).

Figure 1:   Carte géologique simplifiée de la chaine Bético-Rifaine (Michard et al., 2002, modifiée par Romagny, 2011).
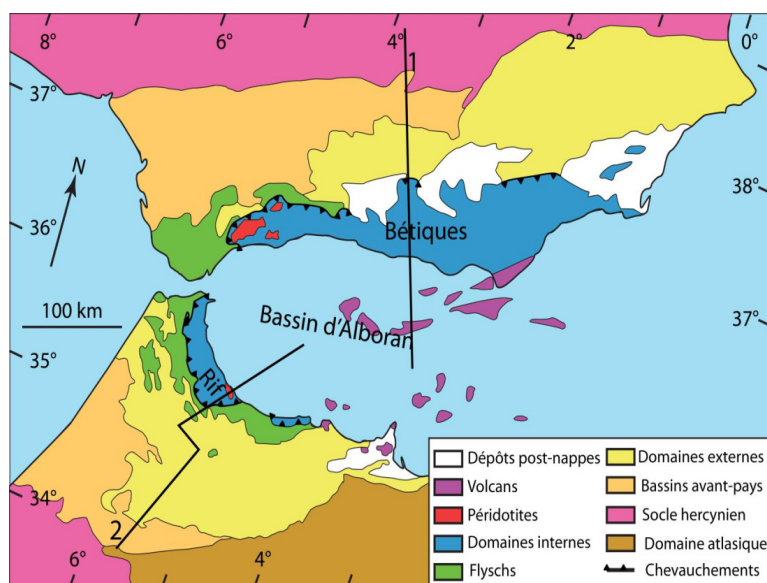
Les études réalisées sur la circulation océanique en Méditerranée et en particulier en mer d'Alboran, ont montré la présence d'un système stratifié de trois couches d'eau qui se distinguent par leurs caractéristiques hydrologiques spécifiques (température, salinité et densité). La couche superficielle est d'origine atlantique, tandis-que les couches intermédiaire et profonde sont d'origine méditerranéenne. Plusieurs études lithologiques, sédimentologiques et minéralogiques ont été réalisées sur des carottes Kullenberg prélevées dans différents endroits du bassin d'Alboran (El Moumni, 1994 ; El Hmaidi, 1999 ; Hassouni, 1997, El Moumni et al., 2000, El Hmaidi et al., 2002). Elles ont montré la présence de quarte faciès sédimentaires d'âge Pléistocène supérieur à Holocène (vases beiges, vases grises, vases grises à monosulfures et sables vaseux). Leur chronologie et stratigraphie (Fig. 2) ont été basées sur des données micropaléontologiques (espèces de foraminifères thermosensibles) accompagnées de plusieurs datations au 14C effectuées sur des niveaux coquilliers. Par manque de datations, les sables vaseux n'ont pas été représentés dans la séquence type, mais leur position par

rapport aux autres faciès, laisserait supposer que ce faciès se serait déposé pendant les différents stades de la transgression tardi-glaciaire - holocène.

Figure 2: Caractéristiques sédimentologiques et stratigraphique des dépôts dans le bassin méridional d'Alboran (El Hmaidi et *al*., 2002).
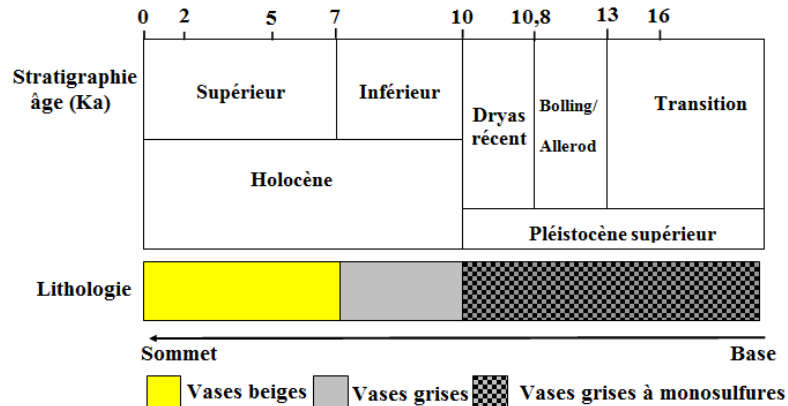
3. Matériel et Méthode
3.1. Base de Données

Les données utilisées sont celles des dépôts pléistocènes-holocènes recoupés par sept carottes Kullenberg prélevées dans la mer d'Alboran (93TG09, 93TG15 et 93TG21 dans la partie orientale et 86K04, 86K09, 86K10 et 86K21 dans la partie occidentale) pendant différentes compagnes océanographiques (El Moumni, 1994, Hassouni, 1997, El Hmaidi, 1999, El Moumni et *al*., 2000, El Hmaidi et al., 2002 et 2011, Zahid, 2011) (Fig. 3).

Figure 3: Modèle numérique du terrain avec situation des carottes étudiées.
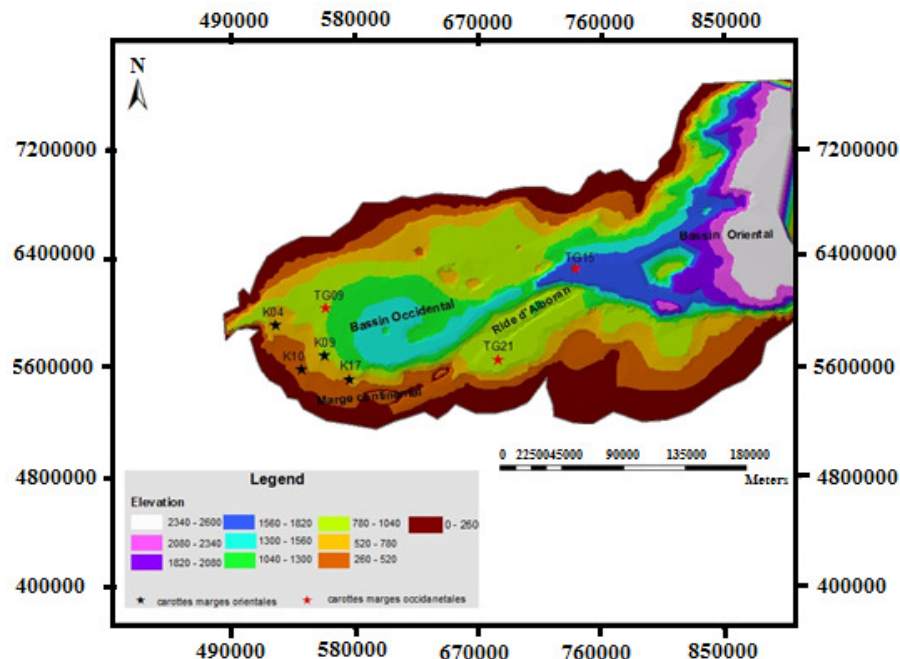
Les deux méthodes de modélisation utilisées pour la prédiction des teneurs en carbone organique dans les dépôts pléistocènes holocènes sont la régression linéaire multiple et les réseaux de neurones formels ou artificiels (Othmani Marabout, 2005, Rude, 2008).

Les 4 bases de données comportent respectivement 196 échantillons pour la base entière du Pléistocène supérieur – Holocène, 99 échantillons pour la base du Pléistocène supérieur, 53 échantillons pour la base de l'Holocène inférieur et 66 échantillons pour la base de l'Holocène supérieur. Pour chaque échantillon, 13 paramètres sédimentologiques, minéralogiques et géochimiques ont été pris en considération (bathymétrie, profondeur des niveaux dans les carottes, % des sables, % des silts, % des Argiles, % Illite, % Kaolinite, % Chlorite, % Smectite, % $CaCO_3$, Médiane, Rapport Silts/Argiles et Rapport Smectite/Illite).

3.2. Régression Linéaire Multiple

L'analyse de la régression linéaire est une méthode statistique qui permet d'étudier le type de relation pouvant exister entre une certaine variable (dépendante) dont on veut expliquer les valeurs et une ou plusieurs autres variables qui servent à cette explication (variables indépendantes). La régression linéaire permet de résumer, d'interpréter et de prévoir les variations d'un caractère dit dépendant (Y) en fonction d'un ou d'autres dit (s) indépendant (s) (X_n) et ce en utilisant une droite. L'équation du modèle est la suivante :

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n$$

Où:

- n est le nombre de variables explicatives,
- Y est la variable dépendantes; X_1, X_2,…, X_n sont les variables indépendantes.
- β_0 est l'ordonnée à l'origine estimée, β_1 ; β_2 ;….. ; β_n sont les pentes (coefficients partiels de régression).

3.3. Réseau de Neurones Artificiels

Le neurone formel est l'élément essentiel d'un réseau de neurones. C'est un opérateur mathématique très simple, dont on peut facilement calculer la valeur numérique. Son fonctionnement est schématisé sur la figure 4. Un neurone formel est une fonction algébrique paramétrée, non linéaire en ses paramètres, et à valeurs bornées. Ses entrées peuvent être les sorties d'autres neurones ou des entrées de signaux extérieurs. Sa sortie est une fonction non linéaire f d'une combinaison linéaire A_j des entrées (P_n). Le potentiel A_j le plus fréquemment utilisé est la somme pondérée des entrées P_n pondérées par les coefficients (W_{nj}) également appelés poids de connexions :

Figure 4: Schématisation d'un neurone formel.
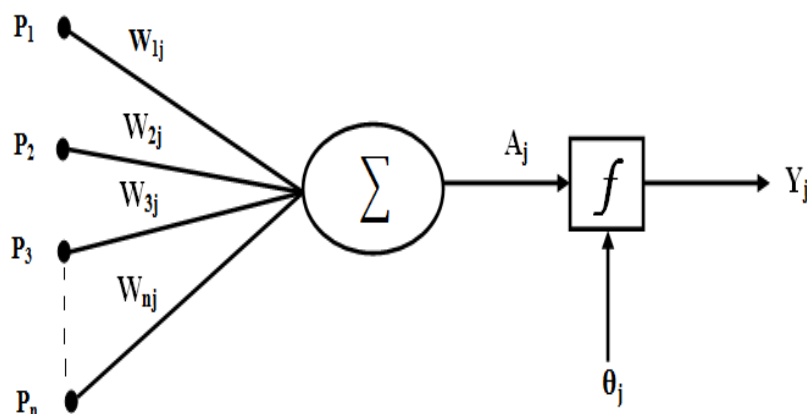
$$A_j = \sum_{i=1}^{n} W_{nj} P_{nj} + \theta_j.$$

Précisons que le poids θ_j est affecté à une entrée constante appelé "biais". Une fonction *f*, appelée fonction d'activation, est appliquée à ce potentiel A_j (Rude, 2008).

4. Résultats et Discutions

Dans la base de données entière de 196 échantillons, l'analyse de la régression linéaire multiple consiste à traiter les liens entre la variable dépendante quantitative à expliquer (Y: teneurs en carbone organique) et plusieurs variables quantitatives explicatives indépendantes (X_n: paramètres sédimentologiques, minéralogiques et géochimiques). Elle tente également de déterminer les équations d'un ajustement polynomial non-linéaire pour l'analyse des liens entre deux variables quantitatives, d'interpréter les coefficients de corrélation et de vérifier le rôle de chaque variable (Fig. 5).

En premier lieu, l'équation prend en considération toutes les 13 variables même celles qui n'ont pas un bon pouvoir d'explication de la variable dépendante:

%C.org = $3{,}64 - 2{,}09.10^{-5} * Bathy - 3{,}09.10^{4} * Niv - 1{,}25.10^{3} * Sab - 1{,}37.10^{-3} * Silt - 2{,}80.10^{3} * Arg + 9{,}54.10^{-3} * Silt/Arg + 3{,}71.10^{-2} * Med - 2{,}81.10^{-2} * Illite - 2{,}69.10^{-2} * Sm - 2{,}07.10^{-2} * Kao - 2{,}67.10^{-2} * Chl + 3{,}91.10^{-2} * Sm/I - 8{,}87.10^{-4} * CaCO_3$

Avec: N = 196 échantillons; le coefficient de détermination $R^2 = 0{,}86$; l'indice de probabilité P < 0,005.

Ensuite, seules les sept variables indépendantes qui ont un meilleur pouvoir d'explication de la variable dépendante ont été retenues et l'équation s'écri:

%C.org = $3{,}64 - 3{,}1.10^{-4} * Niv - 1{,}5.10^{-3} * Sab - 1{,}6.10^{-3} * Silt - 3{,}4.10^{-3} * Arg + 9{,}5.10^{-3} * Silt/Arg + 3{,}7.10^{-2} * Méd - 2{,}9.10^{-2} * Illite$

Avec: N = 196 échantillons; Le coefficient de détermination R2 = 0, 86; L'indice de probabilité P < 0,005.

La valeur du coefficient de détermination a légèrement baissé, mais l'équation est devenue beaucoup plus simple après l'élimination des variables de faible pouvoir d'explication de la variable dépendante. Ce coefficient $R^2 = 0{,}86$, signifie que la corrélation du modèle est moyennement positive. La probabilité strictement inférieure à 0,5%, confirme que le modèle est significatif.

Figure 5:   Relation entre les pourcentages observées des teneurs en carbone organique et celles estimées par la régression linéaire multiple.
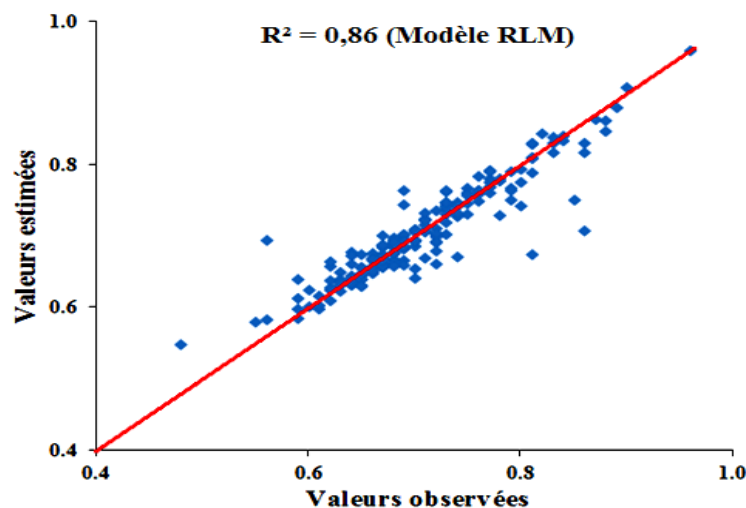
Pour montrer la qualité prédictive des modèles, les données utilisées durant cette étude sont divisées en trois groupes. Le premier groupe correspond à 60% des données totales. Ce groupe servira à entraîner le système.

Le deuxième groupe correspond à 20% des données totales sera utilisé pour valider le réseau et les 20% restantes qui n'ont pas participé à l'apprentissage des modèles seront utilisées comme un test indépendant de la généralisation du réseau. Signalons que, ces trois groupes de données ont été tirés d'une manière aléatoire, parmi les données totales qui n'ont pas participé à la phase d'apprentissage.

Pour améliorer la performance du modèle, plusieurs essais préliminaires ont été réalisés. Ainsi, l'architecture du réseau de neurones est modifiée progressivement jusqu'à l'obtention du modèle le plus performant, en jouant surtout sur le nombre de couches cachées, ou sur celui des neurones cachés et/ou sur le nombre de cycles d'entrainements ou nombre d'itérations. Le nombre choisi pour les neurones cachés (NNC) détermine le degré d'apprentissage (Othmani Marabout, 2005 ; Rude, 2008).

La fonction d'activation utilisée durant cette étude est de type sigmoïde, le taux d'apprentissage (η =0,001).

La figure 6 décrit l'entrainement du réseau. Elle montre qu'au bout de la huitième itération, le résultat désiré est atteint. Avec 13 neurones cachés, les trois courbes relatives à l'évolution de l'erreur quadratique moyenne des trois phases convergent correctement vers le minimum d'erreur quadratique moyenne (MSE).

Figure 6: Evolution de l'erreur quadratique moyenne avec 13 neurones dans la couche cachée.
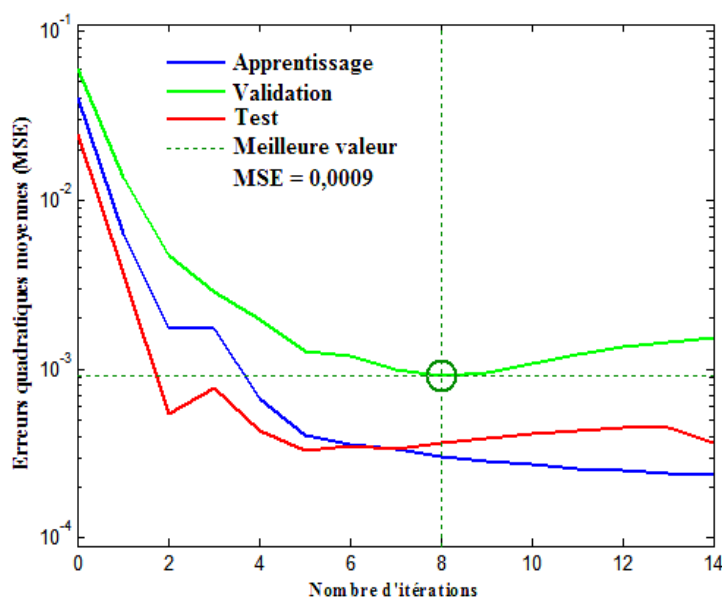
Le réseau a été entraîné jusqu'à atteindre la phase de sur-apprentissage, ce phénomène a été rencontré au bout de 14 itérations. Il est donc intéressant de poursuivre l'apprentissage jusqu'à atteindre cette phase pour le test dans le but de baisser le gradient davantage et de perfectionner donc le réseau (figure 7).

Plusieurs architectures ont été simulées pour l'apprentissage et la validation. Après plusieurs essais sur la base de données entière de 196 échantillons et après avoir obtenu la valeur maximale de corrélation et la valeur minimale de l'erreur quadratique moyenne (notée MSE, Mean Square Error), lorsque NNC=10, l'architecture du modèle de réseau de neurones le plus pertinent pour la prédiction des teneurs en carbone organique est de type [13 -10 -1]. Le modèle est formé donc de 13 neurones pour la couche d'entée (variables indépendantes (explicatives) : paramètres sédimentologiques, minéralogiques et géochimiques), 10 neurones pour la couche cachée et d'un neurone pour la couche de sortie (teneurs en carbone organique) (Fig. 8).

Les résultats obtenus (Fig. 7) permettent de tirer les différentes valeurs relatives aux paramètres d'apprentissage:

- Nombre maximum d'itération (Epochs) = 14
- Erreur quadratique moyenne (MSE) = 10 %
- Taux d'apprentissage (η) = 0,001
- Gradient minimum= 0,00024

Figure 7:   Variations de gradient de l'erreur, du taux d'apprentissage et de l'erreur de validation en fonction du nombre d'itérations.
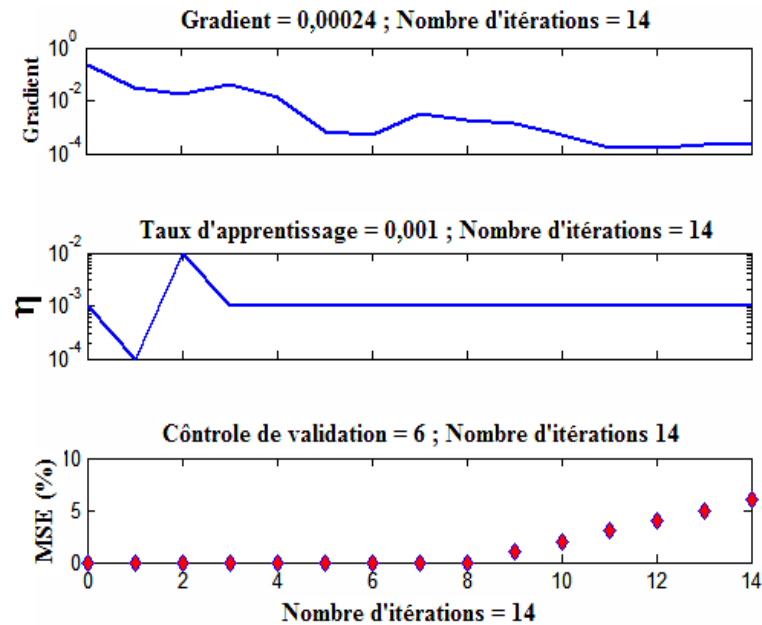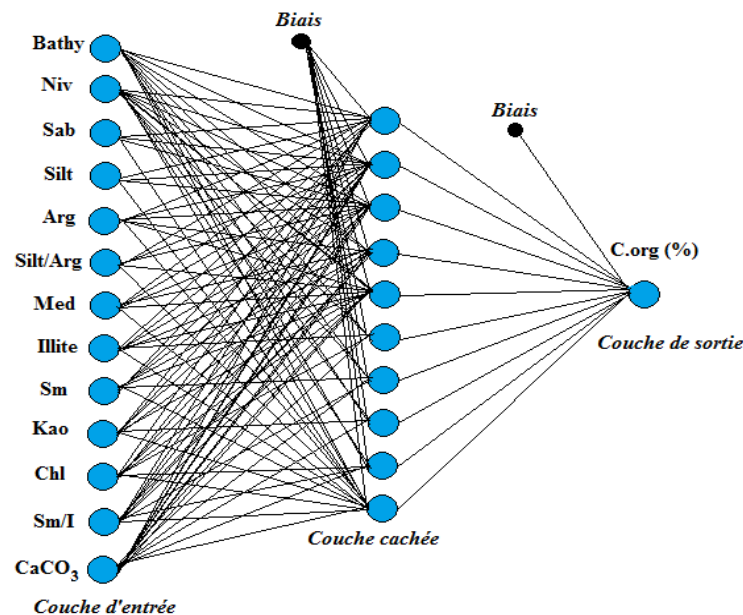

Figure 8:   Architecture du réseau de neurone à trois couches de configuration [13 -10-1] utilisé dans cette étude.

Une fois l'architecture du modèle de réseau de neurones est choisie, le modèle calcule les teneurs en carbone organique. Les résultats de cette prédiction (valeurs estimées) sont comparés aux valeurs mesurées par analyse au laboratoire (valeurs observées) (Fig. 9).

Figure 9:   Relation entre les teneurs observées en carbone organique et celles estimées par les modèles des réseaux de neurones.
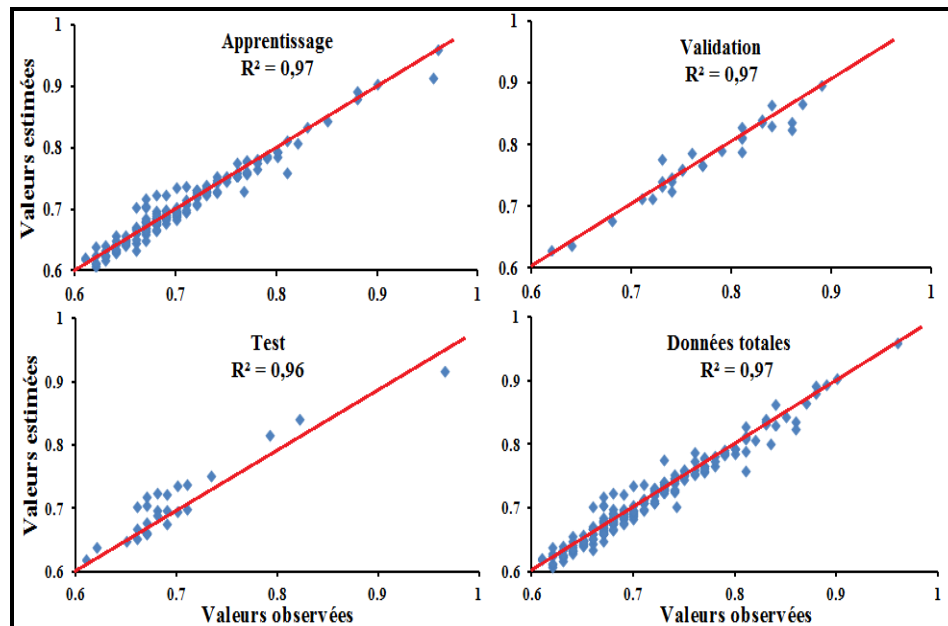
La relation entre les valeurs observées et les valeurs estimées des teneurs en carbone organique montre la performance et la qualité du modèle développé par la méthode stochastique des réseaux de neurones. Cette performance est évaluée par un coefficient de détermination R2 = 0,97 pour l'ensemble de données totales.

Afin de comparer les résultats entre les différentes méthodes numériques (Réseau de neurones et la régression linéaire multiple), deux indices de performance ont été calculés pour chaque série : Le coefficient de détermination (R2) et l'erreur quadratique moyenne (MSE).

Le coefficient de détermination (R^2) est le pourcentage de l'erreur totale sur la variable dépendante Y (teneurs en carbone organique) expliquée par le modèle. Ce coefficient s'exprime selon Bélanger (2005) par :

$$R^2 = \frac{\sum_{i,j=1}^{N}\left(Y_j - Y_{moy}\right)^2}{\sum_{i,j=1}^{N}\left(Y_i - Y_{moy}\right)^2} \; x100 \, .$$

L'erreur quadratique moyenne E est définie par l'équation suivante (Cheggaga et al., 2010) :

$$MSE = E = \frac{1}{2}\sum_{i=1}^{N}\left(Y_j - Y_i\right)^2 .$$

Y$_j$: la sortie obtenue par le réseau
Y$_i$: La cible (la sortie désirée)
Y$_{moy}$: La moyenne des valeurs mesurées
N: le nombre des échantillons.

- **Applications**
  - L'application de la régression linéaire multiple sur la base de données du **Pléistocène supérieur** qui contient 99 échantillons a donné l'équation suivante :

(%C.org) = 3,3509 - $1,2.10^{-5}$ * Bathy - 3.10^{-4} * Niv - $2,7.10^{-3}$ * Sables - $8,9.10^{-4}$ * Silts - $2,9.10^{-3}$ * Argiles + $9,2.10^{-3}$ * Silt/Arg) + $3,2.10^{-2}$ * Médiane

Le coefficient de détermination $R^2 = 0,86$ montre que la corrélation du modèle est moyennement positive. La probabilité, strictement inferieure à 0,5%, confirme que le modèle est significatif. L'architecture du modèle de réseau de neurones qui a donné de bons résultats après 8 itérations pour les dépôts du Pléistocène supérieur est de type [13 - 4 -1] (Tab. 1).

 o L'application de la régression linéaire multiple sur la base de données de **l'Holocène inférieur** qui contient 53 échantillons a donné l'équation suivante :

(%C.org) = 2,7544 + 2,8.10^{-6} * Bathy - 3,5.10^{-4} * Niv - 9,2.10^{-5} * Sables - 9,9.10^{-3} * Silts + 5,6.10^{-3} * Arg + 0,65 * Silt/Arg + 3,5.10^{-2} * Médiane

Le coefficient de détermination $R^2 = 0,99$ indique une corrélation positive importante et que les teneurs en carbone organique sont liées avec les paramètres environnementaux par une relation presque linéaire. La probabilité inferieure à 0,5% signifie un modèle significatif. L'architecture du modèle de réseau de neurones qui a donné de bons résultats après 8 itérations pour les dépôts de **l'Holocène inférieur** est de type [13 - 4 -1] (Tab. 1).

 o L'application de la régression linéaire multiple sur la base de données de **l'Holocène supérieur** qui contient 66 échantillons a donné l'équation suivante :

%C.org = 2,7013 + 3,3.10^{-6} * Bathy - 3,3.10^{-4} * Niv – 1,4.10^{-4} * Sables - 9,7.10^{-3} * Silts + 5,4.10^{-3} * Arg +0,64 * Silt/Arg + 3,2.10^{-2} * Médiane

Le coefficient de détermination $R^2 = 0,99$ montre que la corrélation du modèle est fortement positive, ceci montre que les paramètres étudiés sont liés par une relation presque linéaire. La probabilité, strictement inférieure à 0,5%, confirme que le modèle est significatif. L'architecture du modèle de réseau de neurones qui a donné de bons résultats après 8 itérations pour les dépôts de l'Holocène inférieur est de type [13 - 4 -1] (Tab. 1).

En comparant les résultats, la variable explicative (teneurs en carbone organique) parait présenter une bonne corrélation linéaire avec les paramètres sédimentologiques, minéralogiques et géochimiques dans les quatre bases de données étudiées (Tab. 1).

Pour la base de données entière de 196 échantillons, les coefficients de déterminations calculés par les RNA sont significativement plus élevés (0,97), par contre les coefficients calculés par la RLM sont moins élevés (0,86). D'autre part, les coefficients de détermination obtenus en testant la validité des modèles établis par les RNA sont nettement proches de ceux relatifs à l'apprentissage. Ceci montre une très bonne corrélation entre les valeurs simulées et observées (Modèle RNA) avec un très bon coefficient de détermination. Ce qui prouve, la puissance prédictive de ces modèles établis par les réseaux de neurones dans la prévision des teneurs en carbone organique dans les dépôts du Quaternaire terminal de la mer d'Alboran.

Tableau 1: Coefficients de détermination entre les teneurs en carbone organique observées et prédites par la régression linéaire multiples (RLM) et les réseaux de neurones (RNA) dans les quatre bases de données étudiées. (MSE : Erreur moyenne quadratique).

	Pléistocène sup - Holocène	Pléistocène supérieur	Holocène inférieur	Holocène supérieur
RLM	$R^2 = 0,86$	$R^2 = 0,86$	$R^2 = 0,99$	$R^2 = 0,99$
	Architectures des modèles choisis			
	[13-10 -1]	[13 - 4 -1]	[13 - 4 -1]	[13 - 4 -1]
	Parties des bases de données réservées à l'apprentissage			
RNA	$R^2 = 0,97$ MSE = 0,0003	$R^2 = 0,99$ MSE = 0,000001	$R^2 = 0,99$ MSE = 0,000002	$R^2 = 0,99$ MSE = 0,000001
	Parties des bases de données réservées au test			
	$R^2 = 0,96$ MSE = 0,0003	$R^2 = 0,99$ MSE = 0,00009	$R^2 = 0,99$ MSE = 0,00005	$R^2 = 0,99$ MSE = 0,00009

Les résultats obtenus corroborent ceux des études précédentes qui ont démontré que les modèles des réseaux de neurones produisent de très bons résultats comparativement avec ceux de la

méthode de la régression linéaire multiple. En effet et à titre d'exemple, Bouras et al. (2010) ont montré une performance exceptionnelle pour le modèle RNA par rapport à la méthode linéaire, et surtout dans le traitement des problèmes de prédiction.

D'autre part, Bélanger et al. (2005), dans une étude de prédiction de la température de l'eau, démontrent que les réseaux de neurones artificiels semblent donner un ajustement aux données avec des résultats légèrement meilleures que ceux offerts par la régression linéaire multiple.

Les modèles développés par RNA ont prouvé l'exactitude des résultats obtenus, puisqu'ils sont très proches des mesures réelles (Tab. 1). Ces résultats montrent que le modèle établi par les réseaux de neurones est clairement performant par rapport à celui établi par la méthode de la régression linéaire multiple. Les paramètres sont donc non linéaires du fait que les coefficients sont très élevés dans le cas de l'analyse avec les RNA et moins élevés dans le cas de la RLM.

L'architecture du réseau de neurone utilisée dans cette étude est de type [13-10-1] pour la base de données totale et de type [13 - 4 -1] pour les trois autres bases. Ces architectures ont été obtenues après plusieurs essais. La différence entre ces deux architectures serait probablement en relation avec le nombre des échantillons plus élevé dans la première architecture.

En comparant les équations obtenues, les teneurs en sables et en argiles ont un meilleur pouvoir d'explication des teneurs en carbone organique dans la base de données relative au Pléistocène supérieur. Pour les bases de données relatives à l'Holocène inferieur et supérieur, les teneurs en sables deviennent non significatives, par contre les teneurs en silts et en argiles constituent des paramètres d'important pouvoir pour la prédiction des teneurs en carbone organique. D'autre part, la variable explicative teneurs en carbone organique parait en corrélation linéaire avec les paramètres sédimentologiques, minéralogiques et géochimiques dans les quatre bases de données étudiées.

Chacune des méthodes utilisées pour la prédiction a des avantages et des inconvénients. En premier lieu, les réseaux de neurones sont très efficaces mais offrent une description peu claire de la relation entre les données d'entrée et de sortie. Pour la régression linéaire multiple une équation est déterminée explicitant la relation linéaire entre les variables explicatives d'entrés (paramètres sédimentologiques, minéralogiques et géochimiques) et la variable de sortie (teneurs en carbone organique).

- **Etude des résidus**

L'erreur commise par les modèles établis pour chaque méthode sur un individu de l'échantillon de construction du modèle est appelée résidu (Voyant, 2011). Ainsi l'étude de la relation entre les teneurs estimées en carbone organique par les modèles mathématiques et leurs résidus $(Y_j – Y_i)$ permet d'assurer la performance du modèle et de vérifier empiriquement, entre autres, le bien fondé des hypothèses des modèles.

La figure 10 présente les relations entre les teneurs estimées en carbone organique et leurs résidus obtenus respectivement à l'aide des réseaux de neurones (RNA) et de la régression linéaire multiple (RLM). Elle montre, pour la base de données totale, que les résidus obtenus par les réseaux de neurones sont nettement moins dispersés (plus proche du zéro) et une nette amélioration de la répartition des résidus, comparativement à ceux de la régression linéaire multiple. Cette répartition prouve la puissance prédictive de ces modèles établis par les réseaux de neurones dans la prévision des teneurs en carbone organique à partir des paramètres environnementaux. D'une manière générale, les résultats obtenus sont très satisfaisants et justifient le recours à l'approche par les réseaux de neurones dans la prédiction des teneurs en carbone organique dans les dépôts du Pléistocène – Holocène de la mer d'Alboran. Ceci est en accord avec les résultats de quelques études récentes qui ont démontré que les modèles de régression linéaire multiple sont moins performants comparativement à ceux établis par les modèles de réseau de neurones artificiels (Abdallaoui et al., 2012 ; Bélanger et al., 2005 ; El Badaoui et al., 2012).

Figure 10: Répartition des résidus relatifs aux modèles RNA et RLM pour l'ensemble des données.
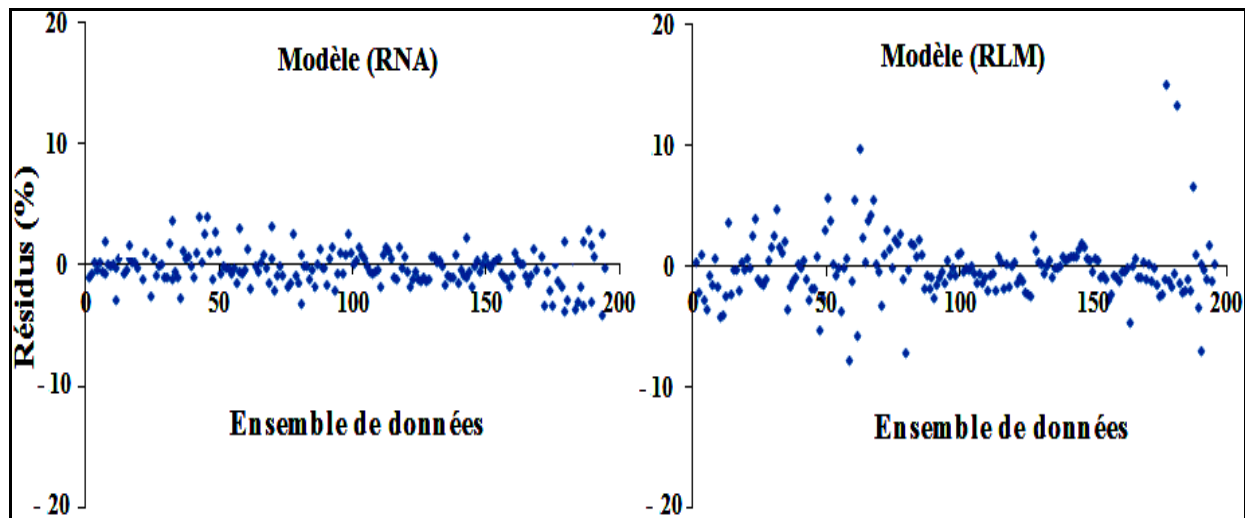
6. Conclusion

La prédiction des teneurs en carbone organique à partir des données sédimentologiques, minéralogiques et géochimiques dans les dépôts pléistocènes holocènes de la mer d'Alboran a été réalisée en utilisant la régression linéaire multiple et les réseaux de neurones. Les réseaux de neurones utilisés sont à couches non-récurrentes, avec un algorithme de levenberg Marquardt et un apprentissage supervisé.

Les résultats obtenus par les deux modèles sont acceptables. Les réseaux de neurones, plus performants, ont démontré une capacité importante d'apprentissages et de prédiction pour les teneurs en carbone organique avec un coefficient de détermination de 0,96 à 0,99 et une erreur quadratique maximale très faible de 0,00009 à 0,0003 pour les quatre bases de données utilisées en plus d'un meilleur choix de l'architecture du réseau réalisé grâce à des essais préliminaires. Pour la régression linéaire multiple les résultats sont moins significatifs avec un coefficient de détermination de 0,86 pour la base de données entière. Ceci montre que les paramètres étudiés sur l'ensemble de données entières sont liés avec les teneurs en carbone organique par une relation non linéaire. Pour la prédiction des teneurs en carbone organique dans les dépôts du Quaternaire terminal de la mer d'Alboran, l'utilisation d'un modèle neuronal de configuration [13 – 10 - 1] donne de meilleurs résultats sur l'ensemble de données totales.

Ce travail de modélisation pourra être appliqué dans la prédiction des teneurs en carbone organique et leur cartographie via le SIG dans le temps pour la période du Pléistocène supérieure - Holocène et dans l'espace à l'échelle de l'ensemble de la mer d'Alboran.

Références

[1] Abdallaoui, A., El Badaoui H., 2011. Prédiction des teneurs en métaux lourds des sédiments à partir de leurs caractéristiques physico-chimiques. *Journal Physical and Chemical News*, 58, 90-97.

[2] Abdallaoui A., El Badaoui H., Lancelot L. (2012). Development of a neural statistical model for the prediction of the concentrations of heavy metals (Fe, Mn and Al) in surface waters: case of the Oued Boufekrane, (Meknes, Morocco). Colloque International Eau et Climat Regards Croises Nord/Sud, Université de Rouen, 25–26 septembre (2012), 15.

[3]   Bélanger M., El-Jabi N., Caissie D., F. Ashkar, Ribi J-M. (2005). Estimation de la température de l'eau en rivière en utilisant les réseaux de neurones et la régression linéaire multiple. *Revue des sciences de l'eau,* 18/3, 403-421.

[4]   Bouras F., Djebbar Y., Abida H., 2010. Estimation de L'envasement des Barrages: une Approche non Paramétrique. *Journal International Network Environmental Management Conflicts*, Santa Catarina – Brazil, 1 (1), 113-119.

[5]   Chabaa S., ZEROUAL A., ANTARI J., 2009. MLP Neural Networks for Modeling non Gaussian Signal", Workshop sur les Technologies de l'Information et de la Communication (WOTIC 09) à Agadir, 58.

[6]   Cheggaga N., Youcef Ettoumi F. (2010). Estimation du potentiel éolien. *Revue des Energies Renouvelables,* SMEE 10 Bou Ismail Tipaza, 99-105.

[7]   El Badaoui H., Abdallaoui A., Lancelot L., 2012. Application des réseaux de neurones artificiels et des régressions linéaires multiples pour la prédiction des concentrations des métaux lourds dans les sédiments fluviaux marocains. *20ème édition du colloque Journées Information Eaux. Université de Poitiers*, 25, 26 et 27 septembre (2012), 15.

[8]   El Hmaidi A., 1999. Caractérisation des dépôts du Quaternaire terminal en Méditerranée occidentale : Aspects sédimentologiques, géochimiques et paleobiologique, cas de la marge du Rhône (Golf du Lion- France) et de la marge de Sebta (Mer d'Alboran-Maroc), *Thèse de Doctorat d'Etat*, Université Moulay Ismail, Faculté des Sciences, Meknès, 242 p.

[9]   El Hmaidi A., El Moumni B., Hassouni F.-Z., Gensous B., Buscail R., & Monaco A., 2002. Evolution des environnements de dépôt au Quaternaire terminal dans le bassin méridional d'Alboran: apport de l'étude de la carotte 93TG-21. *Bulletin de l'Institut scientifique*, Rabat, section Sciences de la Terre, 24, 23-31.

[10]   El Hmaidi A., Zahid S., Abdallaoui A. & El Moumni B., 2011. Application des réseaux de neurones artificiels pour la prédiction des teneurs en carbone organique dans les dépôts du Quaternaire terminal de la mer d'Alboran. *6ème Rencontre des Quaternarites Marocains «RQM6 »,* Faculté des Sciences et Techniques, Tanger, Maroc, Recueil des résumés, 43.

[11]   El Moumni B., 1994. Contribution à l'étude des environnements sédimentaires au Quaternaire terminal en mer d'Alboran : cas de la marge méridionale (marge marocaine), *Thèse de Doctorat d'Etat,* Université Moulay Ismail, Faculté des Sciences, Meknès, 259 p.

[12]   El Moumni B., Semlali H., Ammar A., El Hmaidi A. & Gensous B., 2000. Mécanismes sédimentaires et structuration récente de la marge méditerranéenne marocaine (partie occidentale), *African continental margins of the mediterranean sea,* CIESM workshop séries n°13, Djerba, 27-37.

[13]   Hassouni F-Z., 1997. Contribution à l'étude de la sédimentation profonde en mer d'Alboran : Apport sédimentologiques et micropaléontologique. *Thèse de 3ème Cycle*, Université Mohamed V, Rabat, 168 p.

[14]   Lin Y. C., Jun Zhang and Zhong J., 2008. Application of neural networks to predict the elevated temperature flow behavior of a low alloy steel. *Computational Materials Science*, vol. 43, vol. 752-758.

[15]   Michard A., Chalouan A., Feinberg H., Goff´e B., Montigny R., 2002. How does the Alpine belt end between Spain and Morocco? *Bull. Soc. Geol. Fr.,* 173, 3-15.

[16]   Othmani Marabout F., 2005. Utilisation des réseaux de neurones dans l'estimation des paramètres de la distribution Ki-2 Non Centrale Gamma, *Mémoire de Magister*, Université de Mentouri, Constantine, 120 p.

[17]   Perez P., Trier, A., 2001. Prediction of NO and NO_2 concentrations near a street with heavy traffic in Santiago. *Atmospheric Environment*, 35,1783-1789.

[18]   Romagny A., 2011. Evolution de la surrection de la chaine du Rif (Maroc), *Mémoire de Master*, Université de Nice Sophia Antipolis, 53p.

[19] Rude J., 2008. Développement d'un modèle statistique neuronal pour la description fine de la pollution par le dioxyde d'azote : application à la région parisienne, *Thèse de Doctorat*, Université Paris XII, Paris, 140 p.

[20] Tesson M., 1977. Régime hydrologique et hydrodynamique de la Sebkha Bou-Areg (lagune de Nador- Maroc), *Travaux et Documents de l'Institut scientifique des pêches martines*, n°1, 68 p.

[21] Voyant C. (2011). Prédiction de séries temporelles de rayonnement solaire global et de production d'énergie photovoltaïque à partir de réseaux de neurones artificiels. *Doctorat en physique*, université de Corse-Pascal Paoli école doctorale environnement société / UMR CNRS 6134 (SPE), 257 p.

[22] Zahid S., 2011. Application des régressions linéaires multiples et des réseaux de neurones artificiels pour la prediction des teneurs en Carbone organique dans les depots du quaternaire terminal de la mer d'alboran. *Mémoire de Master*, Université Moulay Ismail, Faculté des Sciences, Meknès, 75 p.

Tolérance des Rhizobia au Stress Salin: Rôle Osmoprotecteur des Exopolysaccharides Produits Par des Souches de Rhizobia Isolées à Partir du Système Racinaire de Médicago (luzerne) Provenant de la Région Ouest d'Algérie

Yamina Alem
Laboratoire de Biotechnologie des Rhizobia et Amélioration des Plantes
Université d'Oran Algérie
E-mail: genieyamina2@yahoo.fr

Zoubida Benbayer-Habchi
Laboratoire de Biotechnologie des Rhizobia et Amélioration des Plantes
Université d'Oran Algérie
E-mail: zoubenbayer@yahoo.fr

Zohra Ighilhariz
Laboratoire de Biotechnologie des Rhizobia et Amélioration des Plantes
Université d'Oran Algérie

Abdelkader Bekki
Laboratoire de Biotechnologie des Rhizobia et Amélioration des Plantes
Université d'Oran Algérie

Résumé

Dans le but de mettre en évidence le rôle protecteur des exopolysaccharides (EPS) rhizobiens dans la tolérance au stress salin, une étude de la production de ces métabolites par des souches de rhizobia appartenant aux genres: *Rhizobium, Sinorhizobium* et *Agrobacterium,* isolées à partir du système racinaire de Médicago de sols salins de la région ouest d'Algérie a été réalisée. Cette étude nous a permis dans un premier temps de déterminer de manière qualitative et quantitative la production des EPS. La quantification des EPS a montré que le taux de production varie d'une souche à l'autre. La plus importante quantité d'EPS est produite par la souche *rhizobium sp*STM 1081(3,20µg/ml). Dans un second temps le test d'efficience des souches productrices a confirmé leur infectivité et leur efficience vis-à-vis de la plante hôte *Medicago sativa*. Par ailleurs, l'évaluation de la tolérance aux concentrations croissantes de Nacl a révélé la capacité des souches les plus performantes à tolérer une salinité allant jusqu'à 800 mM. Ainsi la production d'EPS varierait selon la nature de la souche testée et la concentration en Nacl utilisée. Enfin, l'essai *in vitro* d'amélioration de la tolérance des rhizobia non halophiles à la salinité par combinaison avec des fractions d'EPS produites par la souche la plus performante dans des conditions optimales de culture, a montré le rôle osmoprotecteur des EPS contre le stress salin.

Tolérance des Rhizobia au Stress Salin: Rôle Osmoprotecteur des Exopolysaccharides
Produits Par des Souches de Rhizobia Isolées à Partir du Système Racinaire de
Médicago (luzerne) Provenant de la Région Ouest d'Algérie   415

Motsclés: Exopolysaccharides - Rhizobia – Salinité – Nodulation - *Medicago sativa.*

Abstract

In order to highlight the protective role of exopolysaccharides (EPS) rhizobia in tolerance to salt stress, a study of the production of these metabolites by six strains of rhizobia belonging to the genera *Rhizobium, Sinorhizobium* and *Agrobacterium* isolated from root system of Medicago of saline soils in the western region of Algeria was performed. This study is a first step to qualitatively and quantitatively detect the production of rhizobial EPS. The quantification of EPS produced by six strains showed that the rate of production varies from one strain to another, the strain *Sinorhizobium medicae* STM 1081 is the best producing strain with a production of EPS 3,20µg/ml. Moreover, the efficiency test confirmed their infectivity and effectiveness toward the host plant *Medicago sativa*. In addition, the evaluation of tolerance to increasing concentrations of NaCl showed the ability of strains tested to tolerate salinity up to 800 mM for strain *Sinorhizobium medicae* STM 2233. The EPS production varies depending on the nature of the test strain and the concentration of NaCl used. Finally, the *in vitro* assay, improved tolerance of rhizobia non halophilic to salinity combination with EPS fractions of the performance strain of products in optimal culture conditions, showed the osmoprotecteur role of EPS against salt stress.

Keywords: Exopolysacchaides - Rhizobia – Salinity – Nodulation - M*edicago sativa.*

1. Introduction

Les associations symbiotiques fixatrices d'azote sont responsables de la majeur partie de la fixation biologique d'azote moléculaire du globe. Les plus connues et les mieux étudiées sont établies entre des bactéries du sol de type rhizobia et des plantes de la famille des légumineuses (De Faria *et al.* 1989).

L'exploitation effective de la fixation symbiotique de l'azote pour l'amélioration de la production agricole exige non seulement la sélection du meilleur cultivar hôte mais également que la population des rhizobia soit correctement et suffisamment caractérisée.

Plusieurs études se sont intéressées à la production des exopolysaccharides (EPS) par les rhizobia, à leur fonction dans la détermination de la spécificité de l'interaction entre les deux partenaires symbiotiques, à l'infection des poils racinaires et à la formation des nodosités (Gage, 2004; Morgante *et al.* 2007). La capacité de fixer l'azote dans l'association rhizobia - plante est liée également à leur aptitude à produire les exopolysaccharides (Hebbar *et al.* 1992).

La sélection d'un couple plante hôte et son rhizobium approprié dépend également du milieu édaphique. Il s'avère donc nécessaire d'évaluer les facteurs environnementaux, afin de sélectionner le couple symbiotique ayant les aptitudes nécessaires qui lui permettent de s'établir dans un type de sol donné, et de répondre aux exigences définies. Un des facteurs environnementaux le plus important est la salinité. Lors de l'étude de l'effet de la salinité sur la symbiose, il est intéressant de considérer la tolérance du microsymbiote en vie libre, puisque l'inhibition de la nodulation et de la fixation de l'azote chez les légumineuses sous stress salin, peut s'expliquer en partie par l'incapacité du rhizobium à survivre dans le milieu salin (Zahran et Sprent, 1986; Rai, 1987).

Les exopolysaccharides occupent une place importante dans la protection des bactéries contre le stress environnemental. Ils semblent donner aux bactéries un avantage compétitif avec les souches des rhizobia indigènes en leur permettant de persister dans le milieu salin (Gauri *et al.* 2009).

L'objectif de ce travail est de montrer le rôle protecteur des EPS dans la tolérance à la salinité des souches rhizobiennes productrices d'EPS et d'évaluer l'infectivité et l'efficience de ces souches.

2. Matériel et Méthodes

2.1. Souches Bactériennes

Les six souches de rhizobia appartenant aux genres (*Agrobacterium, Rhizobium, Sinorhizobium*) utilisées dans ce travail appartiennent au laboratoire de Biotechnologie des Rhizobia et Amélioration des Plantes (LBRAP) de l'université d'Oran. La caractérisation génétique de ces souches a été réalisée au niveau du Laboratoire des Symbiose Tropicales et Méditerranéennes LSTM de l'institut de Recherche et de Développement IRD (Montpellier) (Merabet, 2007).

2.2. Milieu de Culture

Le milieu de culture utilisé est le milieu YEM (Yeast Extract Mannitol. Les bactéries sont ensemencées sur milieu solide (2% agar) ou liquide et incubées à une température de 28°C pendant 48 à 72 heures (Vincent, 1977).

2.3. Détection des Exopolysaccharides

La détection des EPS consiste à ensemencer les souches de rhizobia sur milieu YEM solide sélectif additionné d'une quantité de rouge de ruthénium (colorant). Les boites sont incubées à une température de 28°C pendant 48 à 72 heures. Le rouge de ruthénium se fixe sur le peptidoglycane de la paroi bactérienne, ce qui entraine une coloration rose de la colonie d'une souche non-productrice. Ce colorant ne présente pas d'affinité pour les polysaccharides excrétés. les polysaccharides produits masquent alors la coloration, et les colonies productrices apparaissent blanches (Gancel *et al*. 1988).

2.4. Quantification des Exopolysaccharides

Un inoculum initial est obtenu à partir d'une culture de 5 ml de milieu YEM liquide cultivée à 28°C pendant 48 heures puis centrifugé à 6000 tours / minute pendant 15 minutes. Le culot de cellules bactériennes obtenu est resuspendu dans 5 ml de solution de KCl à 0.85% puis inoculé dans un erlen Meyer contenant 100 ml de milieu YEM liquide. Les cultures sont ensuite incubées à 28°C pendant 5jours dans un bain-marie sous agitation constante.

Les cultures sont par la suite centrifugées à 6000 tours / minute pendant 15 minutes à 4°C. Le surnageant est récupéré et le pH ajusté à 7.25.

Les polysaccharides contenus dans le surnageant sont ensuite précipités par l'ajout de 6g de NaCl, suivi par l'addition de 100 ml d'éthanol froid à 95% (V/V). Les échantillons sont gardés à 4°C pendant une nuit puis centrifugés à 3000 tours / minute pendant 15 minutes à 4°C. Le culot obtenu contenant les exopolysaccharides est récupéré puis resuspendu dans 10 ml d'eau distillée stérile. Le dosage des EPS se fait selon la méthode de dosage des sucres totaux (Dubois *et al*. 1956).

2.5. Test d'efficience

Les souches sont testées pour la nodulation avec une espèce de légumineuse *Medicago sativa*. Les plantes sont cultivées sous éclairage et à température ambiante pendant 90 jours. Ceci permet d'évaluer le pouvoir infectif (par le dénombrement des nodosités formées) ainsi que le pouvoir efficient (par la détermination du poids sec de la partie végétative ou de la hauteur des plantes inoculées par la souche en comparaison avec des plantes témoins).

2.6. Tolérance des Souches à Différentes Concentrations de NaCl en Milieu Solide

Afin de déterminer la capacité de tolérance des souches à la salinité, les six souches de rhizobia sont cultivées dans le milieu YEM liquide sans sel à 28°C pendant 48 heures. Ces précultures sont utilisées pour inoculer des boites de Pétri contenant le milieu YEM solide additionné de différentes concentrations de NaCl (100 mM, 200 mM, 400 mM, 600 mM, 800 mM) et des boites témoins sans NaCl.

Tolérance des Rhizobia au Stress Salin: Rôle Osmoprotecteur des Exopolysaccharides
Produits Par des Souches de Rhizobia Isolées à Partir du Système Racinaire de
Médicago (luzerne) Provenant de la Région Ouest d'Algérie   417

2.7. La Production des Exopolysaccharides à Différentes Concentrations de NaCl

L'effet de la concentration de NaCl sur la production des exopolysaccharides a été réalisé en milieu YEM liquide à différentes concentrations de NaCl : 200 mM, 400 mM et 600 mM.

2.8. La Survie des Souches en Présence de Sel

L'estimation de la survie des bactéries en présence de sel est faite par dénombrement des cellules viables à partir des cultures à différentes concentrations de NaCl.

2.9. Essai *in vitro* d'amélioration de la Tolérance des Rhizobia à la Salinité par Combinaison avec des Fractions d'EPS

A fin de tester in vitro la capacité des EPS à rétablir la pression osmotique des souches inhibées (sensibles), une production d'EPS par la souche de rhizobium la plus tolérante à la salinité a servit pour la préparation des EPS à additionner à des cultures en salinité élevée ensemencées avec la souche la plus sensible à la salinité.

Ce test nécessite 9 erlens Mayer et chaque erlen contient 100 ml de milieu YEM liquide additionnée de NaCl à une concentration de 600 mM.

Ces 9 erlens sont répartis en trois lots:

Le premier lot de quatre erlens servira aux cultures test des EPS (fraction d'EPS : EF), additionnées de fraction d'EPS de la souche performantes à différentes concentrations : 1% (EF1), 2% (EF2), 5% (EF5) et 10% (EF10).

Le deuxième lot (4 erlens) a servit aux cultures test du surnageant (CS), additionnés de la culture rhizobienne la plus tolérante au sel à différentes concentrations : 1% (CS1), 2% (CS2), 5% (CS5), 10% (CS10).

Le dernier lot a servit de contrôle positif (C+) (aucun agent protecteur du stress salin et un erlen avec 100 ml de milieu YEM (sans sel) a servi de contrôle négatif (C-).

L'ensemble des 10 cultures ont été ensemencées par la souche indicatrice (sensible à la salinité). Elles sont ensuite incubées pendant 5 jours à 28°C sous une agitation constante.

3. Résultats et Discussion
3.1. Détection des Exopolysaccharides

La croissance des souches utilisées sur le milieu sélectif (rouge de ruthénium) a donné des colonies blanches sur fond rose par le masquage de la couleur rose du milieu grâce aux EPS produits par ces souches (Figure 1). Cette technique a été utilisée pour la sélection de la souche *Streptococcus thermophilus* sf16 possédant le phénotype de production des exopolysaccharides (Stingele *et al.*, 1996).

Figure 1:   La culture de la souche *Rhizobium* sp. STM1081 sur le milieu sélectif incubée à 28°C pendant 72 heures

3.2. Quantification des Exopolysaccharides

Les résultats obtenus montrent une différence dans la production d'EPS chez les souches de rhizobia étudiées (Figure 2). Nos résultats sont en accord avec les travaux de Modi 1989 et Bouzar 1997qui ont étudié les exopolysaccharides des souches de *Rhizobium* et *Sinorhizobium* et ont montré que la quantité d'EPS produite peut varier considérablement d'une souche à l'autre.

Figure 2: Production des exopolysaccharides par les différentes souches de rhizobia
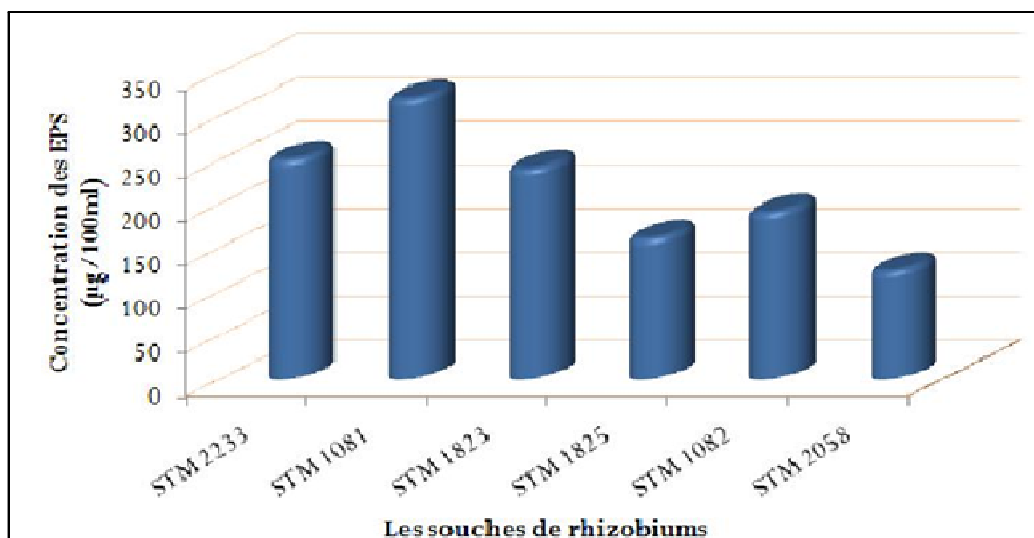
3.3. Test d'efficience

Les résultats obtenus, après 90 jours de culture, montrent que la plante *Medicago sativa* est nodulée par toutes les souches testées de différents genres (*Sinorhizobium*, *Rhizobium* et *Agrobacterium*) (Figure3).

Figure 3: Aspect de la plante *Medicago sativa* nodulée après inoculation par la souche *S. medicae* STM 2233
a: Aspect des racines nodulées sous la loupe.
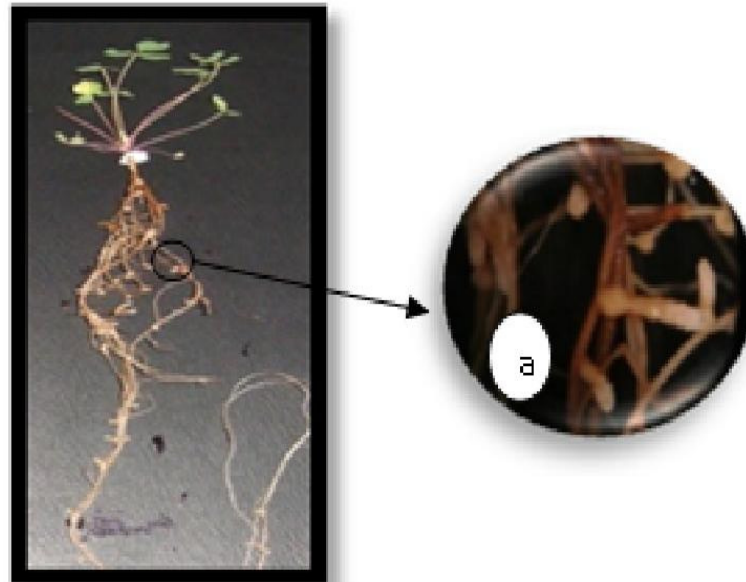
L'effet de l'inoculation sur la croissance des plantes hôtes varie en fonction des souches bactériennes. Les résultats obtenus montrent que toutes les souches ont amélioré favorablement le développement des parties aériennes et des parties racinaires par rapport aux témoins (Figure 4).

Figure 4: Aspect des parties aériennes et racinaires de *Medicago sativa* inoculé avec différentes souches après3 mois de croissance. T: Témoin.; STM 1823: *Rhizobium* sp; STM 2233: *Sinorhizobium medicae*.
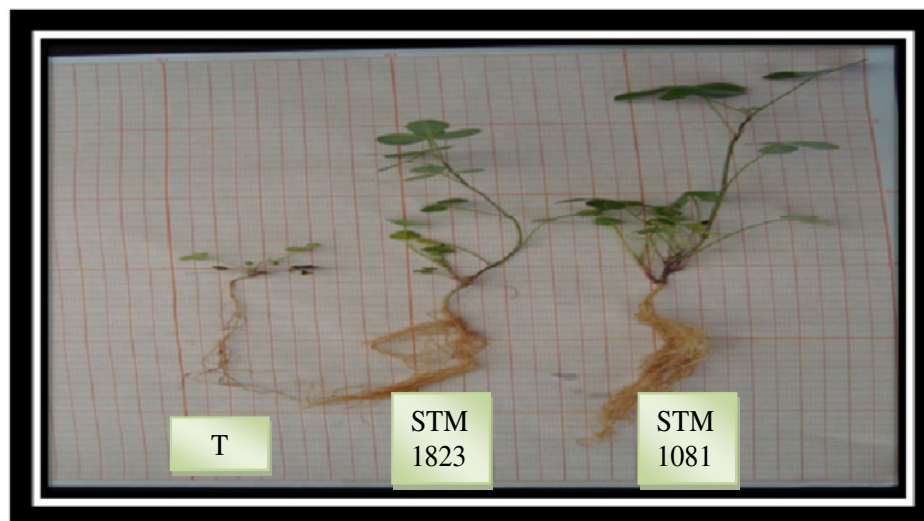
L'ensemble des résultats obtenus montre l'existence d'une relation directe entre l'infectivité de ces souches et la production des EPS. Une relation aussi est observée entre la production d'EPS et la hauteur des tiges principales, sauf pour les plantes innoculées par *Rhizobium sp*. STM 1823 et *Agrobacterium sp*. STM 1082. Par contre, le poids sec de la partie aérienne de la plante ne varie pas en fonction de la production d'EPS. Ces résultats sont représentés dans le tableau 01.

Tableau 1: La production des exopolysaccharides et la nodulation des plantes de *Medicago sativa* par les souches testées.

Souches	EPS µg / 100ml	Nombre de nodules / plante	Poids sec partie aérienne g/plante	Hauteur partie aérienne (cm)
Rhizobium sp. STM 1081	320±14.17	29±3.60	90±18.33	15±3.00
Sinorhizobium medicae STM 2233	250±19.97	21±2.64	94.5±1.32	12±1.00
Rhizobium sp. STM 1823	240±22.91	14±3.05	42±7.08	06±1.73
Agrobacterium sp. STM 1082	190±20.80	11±2.64	66±9.64	07±2.00
Rhizobium sp. STM 1825	160±26.90	09±1.52	19±3.00	4.5±0.50
Sinorhizobium medicae STM 2058	123±27.22	05±2.00	13±2.64	04±1.32

Nos résultats ne sont pas en accord avec ceux obtenus par Singh *et al*.(1991), qui ont travaillé avec la plante *Cajanus cajan* L. En effet, ils ont montré qu'il n'y a aucune relation entre la quantité d'exopolysaccharides produite par des souches de *Rhizobium sp*. et le nombre de nodules. Par contre, ils ont signalé l'absence totale de relation entre la production d'EPS et le poids sec de la partie aérienne, ce qui est en accord avec nos résultats.

Ces résultats peuvent s'expliquer par le rôle des EPS dans les différents processus de nodulation chez certaines légumineuses, probablement comme des signaux transmis à la plante hôte (Mithöfer, 2002). Plusieurs études indiquent que les EPS sont impliqués dans l'adhésion des rhizobia à la surface racinaire (Michiels *et al*. 1991; Gonzalez *et al.* 1996 b), et jouent un rôle dans l'inhibition des défenses de la plante hôte (Pellock *et al*. 2000; Fraysse *et al*. 2003). Les travaux de Morgante *et al*.(2007) ont également montré la participation des EPS rhizobial dans la protection des bactéries contre les systèmes de défense des plantes hôtes durant la symbiose.

3.4. Effet du NaCl sur la Production des Exopolysaccharides et sur la Viabilité des Souches

Rhizobiennes

Les résultats obtenus montrent que toutes les souches peuvent croître jusqu'à une concentration de 600 mM de NaCl à l'exception de la souche *Sinorhizobium medicae* STM 2058 inhibée à cette concentration. De plus, un développement à une concentration saline de 800 mM a été remarqué pour la souche *Sinorhizobium medicae* STM 2233.

La capacité des rhizobia à supporter une augmentation de la salinité varie considérablement d'une espèce à l'autre (Rai, 1983) et même entre les souches de la même espèce (El Sheikh et Wood, 1990). Les souches étudiées s'avèrent très tolérantes à des concentrations élevées de NaCl. Ceci peut s'expliquer par l'isolement de ces souches d'une zone salée. Les auteurs, Mpepereki *et al*. 1997, ont rapporté que l'existence de souches tolérantes à la salinité dans les sites salins peut être l'indication d'une adaptation au stress osmotique.

Les résultats obtenus au cours de cette étude indiquent que le paramètre NaCl ajouté a un effet sur la viabilité bactérienne et sur la production d'EPS. Cet effet est différent pour les six souches de rhizobia étudiées.

Les figures **5A** et **5B** présentent les courbes de viabilité et de production d'EPS de la souche *Sinorhizobium medicae* STM 2233 en fonction de la salinité. Ces courbes se caractérisent par une augmentation de la quantité d'EPS sous stress salin. Cette augmentation est plus importante à 600 mM de NaCl. À cette concentration, les résultats montrent une production d'EPS par la souche STM 2233 quatre fois plus élevé par apport à la culture témoin sans sel.

La détermination du pourcentage de cellules viables à différentes concentration de NaCl a révélé une diminution de la viabilité bactérienne en fonction de la salinité. Lorsque la souche *Sinorhizobium medicae* STM 2233 est cultivée à 600 mM de NaCl, le nombre de cellules viables diminue avec un pourcentage de 14.84% de viabilité par rapport à celui de la culture témoin. Bien que, la croissance des rhizobia soit affectée par la salinité, la survie à des concentrations croissantes de sel dépend de la sensibilité des souches à la salinité.

Les courbes de production d'EPS des deux souches de *Sinorhizobium medicae* (STM 2233 et STM 2058) présentent une relation entre l'augmentation de la salinité et la production d'EPS élevée.

Les courbes de production d'EPS de trois souches de *Rhizobium* sp. (STM 1823, STM 1081 et STM 1825) indiquent que la diminution ou bien l'augmentation de la production d'EPS diffère selon la concentration de NaCl testée.

La courbe de production d'EPS de la souche *Agrobacterium* sp. STM 1082 présente une relation entre l'augmentation de la salinité et la faible production d'EPS.

Degeest *et al.*(2001) et Kang et Park (2010) , rapportent que la production d'EPS varie énormément et dépend des conditions de culture des bactéries, et qu'elle pourrait augmenter en présence de conditions environnementales stimulant leur synthèse.

Figure 5:   Courbe de la survie bactérienne (A) et de la production des exopolysaccharides (B) par la souche *Sinorhizobium medicae* STM 2233 aux différentes concentrations de NaCl.
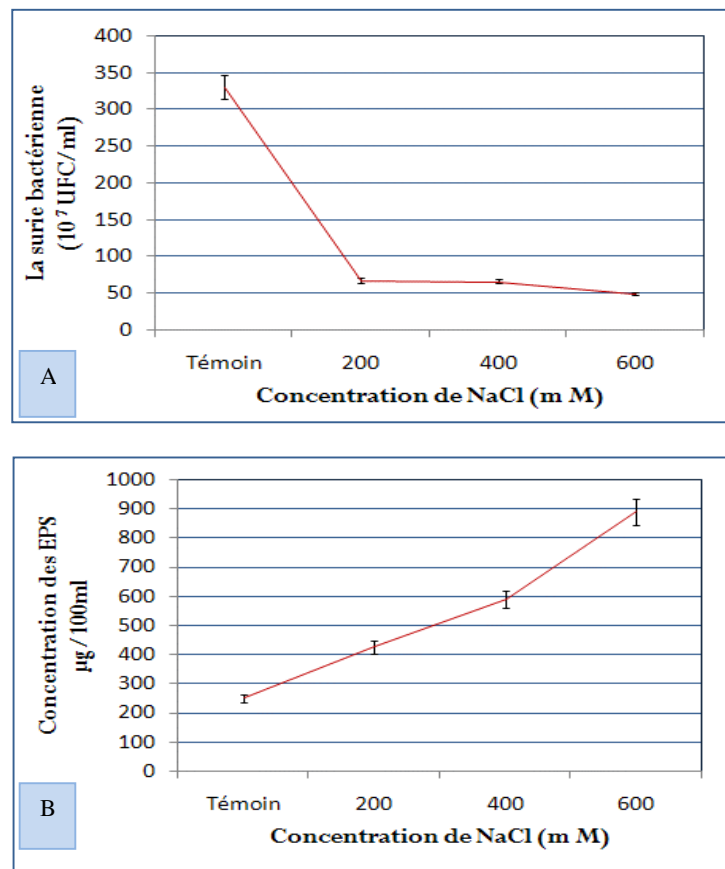
Les résultats obtenus montrent une inhibition des cellules vivantes par les différentes concentrations de NaCl , alors que la production d'EPS est améliorée en présence de sel. On peut donc conclure que l'augmentation de la production d'EPS ne semble pas due à une augmentation du nombre de cellules bactériennes. Ceci est en accord avec les résultats obtenus par Sutherland,(1972) stipulant que des conditions de croissance défavorables stimulent la production d'EPS.

La survie d'une souche bactérienne en présence d'une osmolarité croissante du milieu extèrieur, nécessite une stratégie adaptative pour que la bactérie maintienne une préssion osmotique intracellulaire supérieure à celle du milieu extracellulaire. Plusieurs auteurs s'entendent pour dire que les carbohydrates d'EPS ont un rôle essentiel dans l'adaptation osmotique chez les rhizobiums (Breedveld et Miller, 1994; Le Rudulier, 2005).

Krembs *et al.*(2002)et Junge *et al.*(2004), ont observé chez d'autre groupes microbiens que la quantité d'EPS produite par des microorganismes marins a été augmentée en réponse à des facteurs environnementaux tels que le stress osmotique et la température. Il apparaît évident que les EPS peuvent agir comme une barrière physique de protection (Nichols *et al.* 2005).

Les résultats obtenus montrent que la majorité des souches présentent une bonne tolérance à la salinité. Cependant, dans les environnements salins, la symbiose rhizobia – légumineuse dépend non seulement du microorganisme mais également de la plante hôte (Craig *et al.* 1991; Soussi *et al.* 1999). Il a été rapporté que l'espèce *Medicago sativa* est considérée comme une légumineuse tolérante au sel (Zahran *et al.* 1994).

3.5. Essai in Vitro d'amélioration de la Tolérance des Rhizobia à la Salinité par Combinaison

Avec des Fractions d'EPS

La production des EPS a été assurée par la souche performante *Sinorhizobium medicae* STM 2233, qui a servi pour la préparation des EPS à additionner à des cultures en salinité élevée ensemencée avec la souche la plus sensible à la salinité *Sinorhizobium medicae* STM 2058.

Les résultats obtenus montrent une différence de croissance bactérienne dans les différentes cultures utilisées, avec une croissance bactérienne plus élevée pour le contrôle (-) par rapport à celle de contrôle (+). Ceci pourrait s'expliquer par l'effet inhibiteur du sel utilisé dans le milieu de culture du contrôle (+). Par ailleurs, une croissance bactérienne optimale a été observée dans la culture CS 10%. De plus, la culture EF 1% a donné une bonne croissance bactérienne (Figure 6).

L'utilisation des fractions d'EPS ou bien de surnageant brut contenant des EPS, provenant de la souche *Sinorhizobium medicae* STM 2233 a amélioré la croissance de la souche sensible en condition de stress salin, ce qui indique le rôle des EPS dans la stimulation de la croissance de la souche *Sinorhizobium medicae* STM 2058 et donc leur rôle comme osmo-protecteur (Kang et Park, 2010).

Figure 6: La survie bactérienne de la souche *Sinorhizobium medicae* STM 2058 en présence et en absence d'EPS (fraction et surnageant)
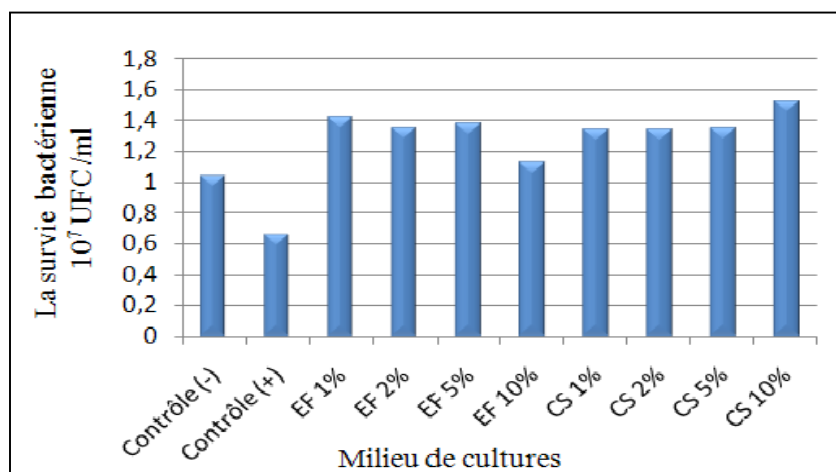
4. Conclusion

La comparaison de la production d'EPS par les six souches testées a montré une variation de la quantité d'EPS produites par ces bactéries, d'une souche à l'autre. De plus le paramètre NaCl ajouté a un effet sur la production d'EPS et sur la viabilité des souches testées. La production d'EPS varie donc selon la souche testée et la concentration de NaCL utilisée. Cette constatation pourrait s'expliquer par l'effet osmoprotecteur des EPS produits vu leur implication dans le phénomène d'osmorégulation.

Tolérance des Rhizobia au Stress Salin: Rôle Osmoprotecteur des Exopolysaccharides
Produits Par des Souches de Rhizobia Isolées à Partir du Système Racinaire de
Médicago (luzerne) Provenant de la Région Ouest d'Algérie 423

Ainsi, la capacité de production d'EPS constituerait une réponse au stress salin visant à assurer une protection des souches bactériennes contre ce type de stress.

Une bonne production d'EPS et une bonne tolérance à la salinité des rhizobia seraient considéré comme critères importants lors de la sélection d'agent rhizobien pour la production d'inoculums efficaces assurant des symbioses effectives en présence de la plante –hôte en milieu salin.

Réferences

[1] Bouzar, F. M, Cerning, J. and Desmazeaud, M., 1997. Exopolysaccharide production and texture-promoting abilities of mixed-strain starter cultures in yogurt production, *J. Dairy. Sci.* 80, pp. 2310-2317.

[2] Breedveld, M. W. and Miller, K. J., 1994. Cyclic β-glucans of members of the family *Rhizobiaceae*, *Microbiol. Rev*. 58, pp. 145–161.

[3] Craig, G. F., Atkins, C. A. and Bell, B. T., 1991. Effect of salinity on growth of four strains of *Rhizobium* and their infectivity and effectiveness on two species of *Acacia*, *Plant. Soil.,* 133, pp. 253-262.

[4] De Faria, S. M., Lewis, G. P., Sprent, J. I. and Sutherland, J. M., 1989. Occurence of nodulation in the leguminosae, *New. Phytologist*. 111, pp. 607-619.

[5] Degeest, B., Vaningelgem, F. and De Vuyst L., 2001. Microbial physiology, fermentation kinetics, and process engineering of heteropolysaccharide production by lactic acid bacteria, *Int. Dairy. J.,* 11, pp. 747-757.

[6] Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. and Smith, F., 1956. Colorimetric method for determination of sugars and related substances. *Anal. Chem.*, 28, pp. 350-356.

[7] El Sheikh, E. A. E. and Wood, M., 1990. Salt effects on survival and multiplication of chickpea and soybean rhizobia, *Soil. Biol. Biochem.*, 22, pp. 343-347.

[8] Fraysse, N., Couderc, F. and Poinsot, V., 2003. Surface polysaccharide involvement in establishing the rhizobium–legume symbiosis. *Eur. J. Biochem.*, 270, pp. 1365–1380.

[9] Gage, D. J., 2004. Infection and invasion of roots by symbiotic, nitrogen-fixing rhizobia during nodulation of temperate legumes, *Microbiol. Mol. Biol. Rev.*, 68, pp. 280-300.

[10] Gancel, F., Novel, G., Carcano, D., Loones, A. and Ramos, P., 1988. Procédé de sélection de clones bactériens producteurs d'exopolysaccharides et clones producteurs obtenus. Brevet No : R 2 632 968 - Al. France 88 08009.

[11] Gauri, S. S., Mandal, S. M., Mondal, K. C., Dey, S. and Pati, B. R., 2009. Enhanced production and partial characterization of an extracellular polysaccharide from newly isolated *Azotobacter* sp. SSB81, *Bioreso. Technol.*, 100, pp. 4240-4243.

[12] Gonzalez, J. E., York, G. M. and Walker, G. C., 1996b. *Rhizobium meliloti* exopolysaccharides: synthesis and symbiotic function. *Gene.,* 179, pp. 141-146.

[13] Hebbar, K. P., Gueniot, B., Heyraud, A., Colin-Morel, P., Heulin, T., Balandreau, J. and Rinaudo, M., 1992. Characterization of exopolysaccharides produced by rhizobacteria, *Appl. Microbiol. Biotechnol.*, 38, pp. 248-253.

[14] Junge, K., Eicken, H. and Deming, J. W., 2004. Bacterial activity at -2 to -20 °C in Arctic wintertime sea ice, *Appl. Environ. Microbiol.,* 70, pp. 550–557.

[15] Kang, Y.-S. and Park, W., 2010. Protection against diesel oil toxicity by sodium chloride-induced exopolysaccharides in *Acinetobacter sp.* strain DR1, *J. Biosci. Bioeng.,* 109, pp. 118-123.

[16] Krembs, C., Eicken, H., Junge, K. and Deming, J. W., 2002. High concentrations of exopolymeric substances in Arctic winter sea ice: implications for the polar ocean cular endothelial growth factor in vitro, *Biochem. Pharmacol.,* 69, pp. 751–759.

[17]   Le Rudulier, D., 2005. Osmoregulation in rhizobia: the key role of compatible solutes, *Grain. Legum.*, 42, pp. 18-19.

[18]   Merabet, C., 2007. Diversité et rôle des rhizobia des régions salées et arides d'Algérie. Thèse de Doctorat en Microbiologie, université d'Oran, 214p.

[19]   Michiels, K. W., Croes, C. L. and Vanderleyden, J., 1991. Two different modes of attachment of *Azospirillum brasilense* sp. to wheat roots. *J. Gen. Microbiol.,* 137, pp. 2241–2246.

[20]   Mithöfer, A., 2002. Suppression of plant defence in rhizobia–legume symbiosis, *Plant. Sci.*, 7, pp. 440-444.

[21]   Modi, V., Mody, B. and Bindra, M., 1989. Extracellular polysaccharides of cowpea rhizobia: compositional and functional studies, *Arch. Microbiol.*, 53, pp. 38-42.

[22]   Morgante, C., Castro, S. and Adriana, F., 2007. Role of rhizobial EPS in the evasion of peanut defense response during the crack-entry infection process. *Soil. Biol. Biochem.*, 39, pp. 1222-1225.

[23]   Mpepereki, S., Makonese, F. and Wollum, A. G., 1997. Physiological characterization of indigenous rhizobia nodulation *Vigna unguiculata* in Zimbabwean soils, *Symbiosis.,* 22, pp. 275-292.

[24]   Nichols, C. A. M., Guezennec, J. and Bowman, J. P. 2005. Bacterial exopolysaccharides from extreme marine environments with special consideration of the southern ocean, Sea Ice, and Deep-Sea Hydrothermal Vents. *Marin.*

[25]   Pellock, B. J., Cheng, H. P. and Walker, G. C., 2000. Alfalfa root nodule invasion efficiency is dependent on *Sinorhizobium meliloti* polysaccharides. *J. Bacteriol.*, 182, pp. 4310-4318.

[26]   Rai, R., 1983. The salt tolerance of *Rhizobium* strains and lentil genotypes and the effect of salinity on the aspects of symbiotic N-fixation, *J. Agric. Sci.*, 100, pp. 81-86.

[27]   Rai, R., 1987. Chemotaxis of salt-tolerant and sensitive *Rhizobium* strains to root exudates of lentil (*Lens culinaris* L.) genotypes and symbiotic N-fixation, proline content and grain yield in saline calcareous soil, *J. Agric. Sci.*, 108, pp. 25-37.

[28]   Singh, S. K., Dudeja, S. S. and Khurana, A. L., 1991. *Rhizobium sp.* exopolysaccharide production, nodulation, and acetylene reduction activity (N_2-fixation) in pigeon pea (*Cajanus cajan* L.), *Biol. Fertil. Soils.*, 11, pp. 30-33.

[29]   Soussi, M., Lluch, C. and Ocaňa, A., 1999. Comparative study of nitrogen fixation and carbon metabolism in two chick-pea (*Cicer arietinum L.*) cultivars under salt stress, *J. Exp. Bot.*, 50, pp. 1701-1708.

[30]   Stingele, F. M, Neeser, J. R. and Mollet, B., 1996. Identification and characterization of the EPS (Exopolysaccharide) gene cluster from *Streptococcus thermophilus* Sfi6**.** *J. Bacteriol.*, 478, pp. 1680-l690.

[31]   Sutherland, I. W., 1972. Bacterial exopolysaccharides, *Advances. Microbial. Physiol.,* 8, pp. 143-213.

[32]   Vincent, J. M., 1977. Root nodule of symbiosis with *Rhizobium* in: the biology of nitrogen fixation (*Quispel.A*.Ed.) North-Holland, Amsterdam., 1, pp. 256-341.

[33]   Zahran, H. H., Räsänen, L. A., Karsisto, M. and Lindström, K., 1994. Alteration of lipopolysaccharide and protein profiles in SDS-PAGE of rhizobia by osmotic and heat stress,*World. J. Microbiol. Biotechnol.*, 10, pp. 100-105.

[34]   Zahran, H. H. and Sprent, J. E., 1986. Effet of sodium chloride and polyethylene glycol on root-hair infection and nodulation of *Vicia faba* L. plants by *Rhizobium leguminosarum, Planta.*, 167, pp. 303-309.

Exact Analytic Solution for Telegraph Equation by Reduced Differential Transform Method

Emad A. Az-Zo'bi

Department of Mathematics and Statistics
Mutah University, Mutah P. O. Box 7
E-mail: eaaz2006@yahoo.com

Abstract

In this work, the reduced differential transform method is proposed for solving different forms of telegraph equation. The exact semi-analytic solution is represented in the form of rapidly convergent series with easily computable components. The proposed iterative scheme can be easily applied to many linear and nonlinear problems. Some illustrative examples are given to demonstrate the efficiency and effectiveness of the method.

Keywords: Reduced differential transform method; Telegraph equations; Exact solution.

1. Introduction

Consider an infinitesimal piece of telegraph wire as an electrical circuit, which consists of resistor of resistance $R\,dx$, and a coil of inductance $L\,dx$. If $i(x,t)$ is the current through the wire, the voltage across the resistor is $i_t\,R\,dx$, while that across the coil is $i_t\,L\,dx$. Denoting by $u(x,t)$ the voltage at position x and time t. The change in voltage between the ends of the piece of wire is

$$du = -i\,R\,dx - u_t\,L\,dx \tag{1}$$

Suppose further that current can escape from the wire to ground, either through a resistor of conductance $G\,dx$, or through a capacitor of capacitance $C\,dx$. The amount of the current escapes through the resistor is $uG\,dx$. Because the charge on the capacitor is $q = uC\,dx$, the amount of the current escapes from the capacitor $u_t C\,dx$. In total

$$di = -i\,uG\,dx - u_t\,C\,dx \tag{2}$$

with dividing by dx, both sides of (1) and (2) and taking the limit $dx \to 0$, we get the differential equations

$$u_x + Ri + Li_t = 0, \tag{3}$$

$$Cu_t + Gu + i_x = 0, \tag{4}$$

By $\partial/\partial x$, of (3) and $\partial/\partial t$, of (4), we have

$$u_{xx} + Ri_x + Li_{tx} = 0, \tag{5}$$

$$Cu_{tt} + Gu_t + i_{tx} = 0. \tag{6}$$

From (4) and (6), we obtain

$$i_x = -Cu_t - Gu,$$ (7)

$$i_{tx} = -Cu_{tt} - Gu_t.$$ (8)

Substituting (7) and (8) into (5) gives

$$u_{tt} + \left(\frac{G}{C} + \frac{R}{L}\right)u_t + \frac{G}{C}\frac{R}{L}u = \frac{1}{LC}u_{xx}.$$ (9)

Let $\alpha = G/C$, $\beta = R/L$ and $c^2 = 1/LC$. Thus

$$u_{tt} + (\alpha + \beta)u_t + \alpha\beta u = c^2 u_{xx},$$ (10)

where $u(x,t)$ denotes voltage at position x at the time t. Also by using $\partial/\partial t$, of (3) and $\partial/\partial x$, of (4), we have

$$i_{tt} + (\alpha + \beta)i_t + \alpha\beta i = c^2 i_{xx},$$ (11)

where $i(x,t)$ is current through the wire. Eqs. (10) and (11) are called Telegraph equation.

Recently, Adomian decomposition method (Biazar and Ebrahimi, 2007), variational iteration method (Biazar et al, 2009), homotopy perturbation method (Raftari and Yildirim, 2012), homotopy analysis method (Rajaraman, 2012) and differential transform method (Biazar and Eslami, 2010) were used to handle telegraph equation. This work deals with the problem by utilizing the reduced differential transform method that is well addressed in (Keskin and Oturanc, 2009), (Keskin, 2010) and (Az-Zo'bi, 2013).

2. The Reduced Differential Transform Method

We present some basic definitions and theorems of RDTM (Keskin and Oturanc, 2009), (Keskin, 2010) and (Az-Zo'bi, 2013).

Definition 2.1. If the function $u(x,t)$ is analytic and differentiated continuously with respect to time t and space x in the domain of interest, then let,

$$U_k(x) = \frac{1}{k!}\left[\frac{\partial^k}{\partial t^k}u(x,t)\right]_{t=0},$$ (12)

where the $t-$dimensional spectrum function $U_k(x)$ is the transformed function.

As mentioned above, the lowercase $u_k(x)$ represent the original function while the uppercase $U_k(x)$ stands for the transformed function.

Definition 2.2. The differential inverse transform of $U_k(x)$ is defined as follows:

$$u(x,t) = \sum_{k=0}^{\infty} U_k(x)t^k.$$ (13)

From Eqs.(12) and (13) can be concluded

$$u(x,t) = \sum_{k=0}^{\infty} \frac{1}{k!}\left[\frac{\partial^k}{\partial t^k}u(x,t)\right]_{t=0} t^k.$$ (14)

From the above definitions, the fundamental theorems of reduced differential transform are:

Theorem 2.1. If $u(x,t) = \alpha v(x,t) \pm w(x,t)$ then,

$$U_k(x) = \alpha V_k(x) \pm W_k(x).$$
(15)

where α is an arbitrary constant.

Theorem 2.2. If $u(x,t) = x^m t^n$ then,

$$U_k(x) = x^m \delta(k-n), \quad \delta(k) = \begin{cases} 1 & ,k=0 \\ 0 & ,k \neq 0 \end{cases}$$
(16)

Theorem 2.3. If $u(x,t) = x^m t^n v(x,t)$ then,

$$U_k(x) = x^m V_{k-n}(x).$$
(17)

Theorem 2.4. If $u(x,t) = v(x,t)w(x,t)$ then,

$$U_k(x) = \sum_{r=0}^{k} W_r(x)V_{k-r}(x) = \sum_{r=0}^{k} V_r(x)W_{k-r}(x).$$
(18)

Theorem 2.5. If $u(x,t) = \dfrac{\partial^r}{\partial t^r} v(x,t)$ then,

$$U_k(x) = (k+1)\ldots(k+r)V_{k+r}(x).$$
(19)

Theorem 2.6. If $u(x,t) = \dfrac{\partial^r}{\partial x^r} v(x,t)$ then,

$$U_k(x) = \frac{\partial^r}{\partial x^r} V_k(x).$$
(20)

Theorem 2.7. If $u(x,t) = v(x,t)w(x,t)\omega(x,t)$ then,

$$U_k(x) = \sum_{r=0}^{k} \sum_{t=0}^{k-r} V_r(x)W_t(x)\Omega_{k-r-t}(x).$$
(21)

Theorem 2. 8. If $u(x,t) = v^n(x,t)$, $n \in \quad$, then,

$$U_k(x) = \sum_{r_1=0}^{k} \sum_{r_2=0}^{k-r_1} \cdots \sum_{r_{n-1}=0}^{k-\sum_{t=1}^{n-2} r_t} V_{r_1}(x)V_{r_2}(x)\cdots V_{k-\sum_{t=1}^{n-1} r_t}(x).$$
(22)

Proof. See Az-Zo'bi (2013)

Theorem 2.9. If $u(x,t) = v^{n-m}(x,t)\left(\dfrac{\partial}{\partial x} v(x,t)\right)^m$, $n, m \in \quad$, then,

$$U_k(x) = \sum_{r_1=0}^{k} \sum_{r_2=0}^{k-r_1} \cdots \sum_{r_{n-1}=0}^{k-\sum_{t=1}^{n-2} r_t} V_{r_1}(x)V_{r_2}(x)\cdots V_{r_{n-m}}(x)\frac{\partial}{\partial x}V_{r_{n-m+1}}\cdots(x)V_{k-\sum_{t=1}^{n-1} r_t}(x).$$
(23)

Proof. See Az-Zo'bi (2013)

3. Applications

In this section, the reduced differential transform method [6-8] will be applied for solving four equations of linear and nonlinear forms. The results reveal that the method is very effective and simple.

Example 3.1. Consider the linear telegraph equation

$$\frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2} + 2\frac{\partial u}{\partial t} + u$$

(24)

Subject to the initial data

$$u(x,0) = e^x, \quad u(x,0) = -2e^x$$

(25)

Operating the reduced differential transformation to Eq. (24) gives

$$\frac{\partial^2 U_k(x)}{\partial x^2} = (k+1)(k+2)U_{k+2}(x) + 2U_{k+1}(x) + U_k(x).$$

(26)

The converted initial conditions (26) are

$$U_0(x) = e^x, \quad U_1(x) = -2e^x.$$

(27)

Substituting Eq. (27) into Eq. (26) and by recursive method, the first few values of the sequence $\{U_k(x)\}$ are

$$U_2(x) = 2e^x, \quad U_3(x) = -\frac{4}{3}e^x, \quad U_4(x) = \frac{2}{3}e^x, \quad ....$$

Substituting all $U_k(x)$ into Eq. (13), we have series solution as follows:

$$u(x,t) = e^x\left(1 - 2t + 2t^2 - \frac{4}{3}t^3 + \frac{2}{3}t^4 + ...\right)$$

(28)

This is the same result with the closed form solution of the problem given by $u(x,t) = e^{x-2t}$ as $k \rightarrow \infty$.

Example 3.2. Consider the linear telegraph equation

$$\frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2} + 4\frac{\partial u}{\partial t} + 4u$$

(29)

With initial conditions

$$u(x,0) = 1 + e^{2x}, \quad u(x,0) = -2.$$

(30)

The reduced differential transformation of Eq. (29) and Eq. (30) gives

$$\frac{\partial^2 U_k(x)}{\partial x^2} = (k+1)(k+2)U_{k+2}(x) + 4U_{k+1}(x) + 4U_k(x).$$

(31)

$$U_0(x) = 1 + e^{2x}, \quad U_1(x) = -2.$$

(32)

By applying initial conditions Eq. (32) into Eq. (31), we obtain

$$U_2(x) = 2, \quad U_3(x) = -\frac{4}{3}, \quad U_4(x) = \frac{2}{3}, \quad ....$$

Taking the inverse transform we get the series solution

$$u(x,t) = e^x + \left(1 - 2t + 2t^2 - \frac{4}{3}t^3 + \frac{2}{3}t^4 + ...\right) = e^{2x} + e^{-2t}.$$

(33)

Which is the exact solution of our problem (Biazar and Eslami, 2010).

Example 3.3. The linear telegraph equation Eq. (30) subject to the initial conditions

$$u(x,0) = e^x, \quad u(x,0) = -e^x,$$

(34)

has the exact solution $u(x,t) = e^{x-t}$. The reduced differential transformation of Eq.(30) was derived in Eq. (32). The transformed initial data are

$$U_0(x) = e^x, \quad U_1(x) = -e^x.$$

(35)

Recursively, by substituting converted initial conditions Eq. (35) into Eq. (31), we have

$$U_2(x) = \frac{e^x}{2}, \ U_3(x) = -\frac{e^x}{6}, \ U_4(x) = \frac{e^x}{24}, \dots.$$

Applying the inverse reduced differential transform we get the series solution

$$u(x,t) = e^x \sum_{k=0}^{\infty} \frac{(-1)^k t^k}{k!} = e^{x-t}, \tag{36}$$

that coincides with the given exact solution.

Example 3.4. Consider the nonlinear telegraph equation

$$\frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2} + 2\frac{\partial u}{\partial t} + u^2 - e^{2x-4t} + e^{x-2t}. \tag{37}$$

With the initial conditions

$$u(x,0) = e^x, \ u(x,0) = -2e^x. \tag{38}$$

Operating the reduced differential transformation to Eq. (37), and using related theorems, yields to

$$\frac{\partial^2 U_k(x)}{\partial x^2} = (k+1)(k+2)U_{k+2}(x) + \sum_{r=0}^{k} U_r(x)U_{k-r}(x) - \frac{(-4)^k}{k!}e^{2x} + \frac{(-2)^k}{k!}e^x. \tag{39}$$

The transformed initial conditions Eq. (38) are

$$U_0(x) = e^x, \ U_1(x) = -2e^x. \tag{40}$$

Recursively, as in the previous examples, the following values of the $U_k(x)$ are

$$U_2(x) = 2e^x, \ U_3(x) = -\frac{4}{3}e^x, \ U_4(x) = \frac{2}{3}e^x, \dots.$$

Substituting all $U_k(x)$ values into Eq. (13), we have series solution as follows:

$$u(x,t) = e^x\left(1 - 2t + 2t^2 - \frac{4}{3}t^3 + \frac{2}{3}t^4 + \dots\right) = e^{x-2t}, \tag{41}$$

which is an exact solution.

4. Conclusions

In this paper, we consider the second order partial differential equation known as the telegraph equation for finding semi-analytic solutions via reduced differential transform method. It is observed that the reduced differential transform method is very efficient, fully compatible with the complexity of such problems, and presented to overcome the demerit of complex calculation of differential transform method for solving linear and nonlinear partial differential equations. It may be concluded that the presented methodology is very powerful and efficient technique in finding analytical solutions for wide classes of problems and can be also easy to be extended to other partial differential equations.

References

[1]   Az-Zo'bi E., 2013. Reduced Differential Transform Method for Solving Shock Wave Equation, Archives Des Sciences, 66 (5), 146-158.

[2]   Biazar J. , Ebrahimi H., and Ayati Z., 2009. An approximation to the solution of telegraph equation by variational iteration method, Numerical Methods for Partial Differential Equations 25 (4), 797-801.

[3]   Biazar J. and Ebrahimi H., 2007. An Approximation to the Solution of Telegraph Equation by Adomian Decomposition Method, International Mathematical Forum 2 (45), 2231-2236.

[4]   Biazar J. and Eslami M., 2010. Analytic solution for Telegraph equation by differential transform method, Physics Letters A 374, 2904–2906.

[5]   Keskin Y., 2010. Ph.D. thesis, University of Selcuk.

[6]   Keskin Y. and Oturanc G., 2009. Reduced Differential Transform Method for Partial Differential Equations. International Journal of Nonlinear Sciences and Numerical Simulations 10 (6), 7414-749.

[7]   Raftari B. and Yildirim A., 2012. Analytical Solution of Second-Order Hyperbolic Telegraph Equation by Variational Iteration and Homotopy Perturbation Methods, Results in Mathematics 61 (1-2), 13-28.

[8]   Rajaraman R., 2012. Analytical Solutions for the Different Forms of Telegraph Equations by Homotopy Analysis Method, he Global Journal of Science Frontier Research, Mathematics and Decisions Sciences 12 (5), 7-12.

The Relationship Between Hardiness and Hopefulness with Life Satisfaction

Ghodsy Ahqhar
*Assistant Professor, Member of Scientific Board of Teaching and Training
Research Center, University, Southern Tehran Branch*

Amineh Ahmadi
*Professor of Islamic Azad University of Southern Tehran Branch University
Southern Tehran branch*

Forugh Ashqali Farahani
*Post Graduate of Training Sciences of Planning Tendency of Islamic Azad University
Southern Tehran Branch*

Abstract

      Hardiness is one of personality traits which is considered as a factor for promoting psychological health. It expedites healthiness and leads to constancy and compatibility. Also study of hopefulness has a significant importance as one of the basic variables of psychological health. One of the needs of a society is individuals' feeling of life satisfaction. Life satisfaction makes security, comfort and all-out confidence in the present and future. The present study investigates the relationship between hardiness and hopefulness with life satisfaction of female state high school students of Tehran city. The participants include all guidance school girl students of Tehran in 1391-1392 educational year. 300 students were selected as sample using Kokoran sampling formula and stratified sampling. Three instruments including Kubasa hardiness questionnaire by Basharat(1997) with reliability and validity of 0.091, hopefulness questionnaire by snyder & lopez(2002)with reliability and validity of 0.094 and life satisfaction questionnaire (mslss) Hipobner (2001) with reliability and validity of 0.087 were used to collect data. SPSS software was used to analyze descriptive and referential statistics including multi-variable regression. Supporting research hypotheses, the results of the study showed that among hardiness sub-scale, challenge and control had a negative meaningful relationship with life satisfaction (p<0.05). hopefulness sub-scales (management and strategy) showed positive relationship with students' life satisfaction which is statistically meaningful (p<005).

  Keywords: Hardiness, hopefulness, students, female students

Introduction

Hardiness is one of the recent theories emanated from positive psychological movement. H is one of personality traits which is considered as a factor in promotion of psychological health. It facilitates healthiness and results in constancy and compatibility. Hardiness is a set of beliefs and skills which provide the valor of facing with life stressing situations (Medi, 2007). Hardiness not only decreases stress but also develops the useful confronting skills. Hard people are more tolerant of tension, stress

and attrition (Sharon and Leslie, 2003. Cited in Nemat Tavoosi, 1387). Hardiness influences individuals' confrontation with different problems of life through making special intrinsic motivation. Hardiness causes people to look at stress of different factors more realistically and widely. It is a source of knowledge through which the person gets access to more sources to answer the questions. Hardiness is a basic-controlled feeling which lets the hard person to draw and access to a set of useful strategies to deal with different stresses (Kubasa,1982). Hardiness provides proper understanding of exterior conditions and making right decisions about the self (Medi and Kubasa, 1984.cited in Jamhari, 1381). Having a passing look at testing process in different fields of psychology, it becomes clear that scientist have focused firstly on human weaknesses in producing psychological theories measurement strategies. So researchers selected some variables like depression, anxiety, hostility and incapacitation for measurement. Nowadays we can use similar instruments and techniques to measure human's abilities. This line of research titles as" positive psychology" has attracted significant attention in the first volume of " American psychology" journal in 2000. Hopefulness is one basic human abilities which has been studied in this field. It was in the starting points of positive psychology that Shneider et al conceptualized hopefulness and designed it measurement tools (Suldo Valle & Huebner, 2006). Human is a purposeful creator which seeks prosperity and well-fare. He doesn't feel satisfaction, well-being and prosperity until he accesses to whatever he wants. Firmly it can be claimed that all efforts of human beings are for reaching well-fare, satisfaction and prosperity. It can be said that satisfaction feeling is one the most important backings to face with problems. People are faced with some conditions in social and personal life which reacting to these problems influences their life directly and provide them with the satisfaction for which they yearn. Life satisfaction is one of the needs of the society. It creates an all-out feeling of security and confidence in the present and future time. To form economic prosperity, investment and programming need the least of secure and certain conditions which shows persons' satisfaction from social life. In addition to being a need for human beings, satisfaction feeling is a very important factor in development and progress of every country. Having the feeling of life satisfaction is necessary for society and individuals. However feeling and satisfaction in life depend greatly on personal conditions, social factors have more powerful role in its increase and decline. Society provides the conditions which can guide the person to achieve his personal goals and wishes. It also provides the conditions in which the person can act in reciprocal interaction and the relationship with those who provide him with peace, security and certainty for a proper life. Life satisfaction is a mixture of social and individual conditions and a sign of positive view toward the environment where the person lives in. life satisfaction, well-fare feeling, reciprocal trust, commitment and similar cases are all in one cultural cluster which show people view toward themselves and the world around them. Low satisfaction is related to negative approaches toward the society to some extent. Probably the main reason of this condition is the situations that society provides with goals fulfillment and making a security emanated from these fulfillments. Feeling security through needs satisfaction and goals fulfillment are among fundamental factors which develops life satisfaction among society. Also life satisfaction is studied as one of indices of social capital which is a dimension of social development. The present research studies effective factors on individuals' life satisfaction. The presupposition is based on Abraham Maslow theory stating that if instinctive needs of people including physical needs, social security, social needs, affection and feeling of attachment to others, needs to be approved, respected and feeling of worthiness and self-discovery are provided, life satisfaction will come to high and desirable status. In this framework, security needs, social relations and the need to be approved and respected can be included in social factors based on their indices and introducers, so that with evaluating the rate of individuals' possession of these needs investigate their effects on people's life satisfaction.

This study investigates the relationship between hardiness and hopefulness of high school female students of Tehran city with their life satisfaction.

Research hypotheses:
1. There is a positive relationship between hardiness (commitment, challenge, control) and students' life satisfaction?

2. There is a positive relationship between hopefulness (management, strategy) and students' life satisfaction.

Research Methodology

The present research is correlational. The participants include 300 female state high school students of Tehran city in 1391-1392 educational year selected by Kokoran formula as the sample. Data were collected by three standard questionnaires including Kubasa hardiness questionnaire by Basharat(2009) with reliability and validity of 0.091, hopefulness questionnaire by snyder & lopez(2002)with reliability and validity of 0.094 and life satisfaction questionnaire (mslss) Hipobner (2001) with reliability and validity of 0.087 were used to collect data **.**

Results
A) Data Description

Table 1:   Sub-scales of students' hardiness

index hardiness	mean	Standard deviation
challenge	24.10	4.53
commitment	25.35	4.94
Control	24.63	5.32
Hardiness total score	74.07	10.61

Graph 1: Bar graph of mean comparison of students' hardiness
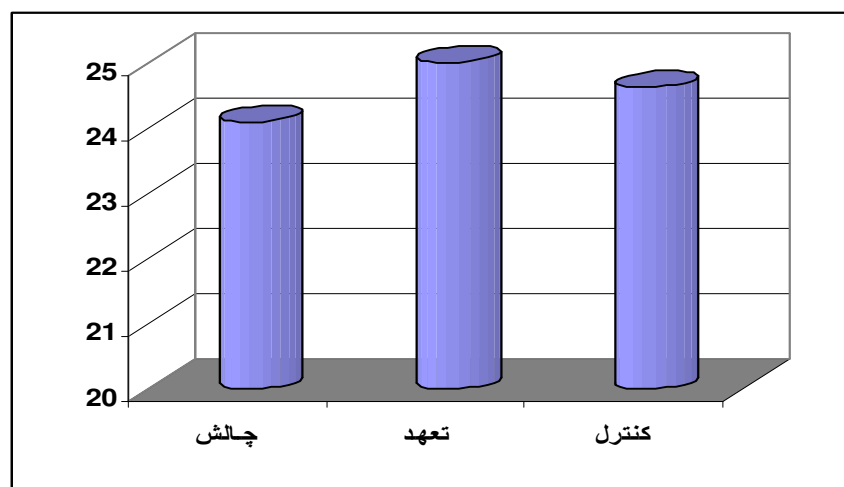
The results of table and graph 1 show that commitment sub-scale with the mean of 25.3 is the highest hardiness scale. Total hardiness score of students is 74.04 with standard deviation of 10.6.

Table 2:   Sub-scales of students' hopefulness

Scale hopefulness	mean	Standard deviation
management	13.17	2.22
strategy	13.10	2.09
Total score of hopefulness	**26.29**	**3.84**

Graph 2: Bar graph of students' hopefulness sub-scales
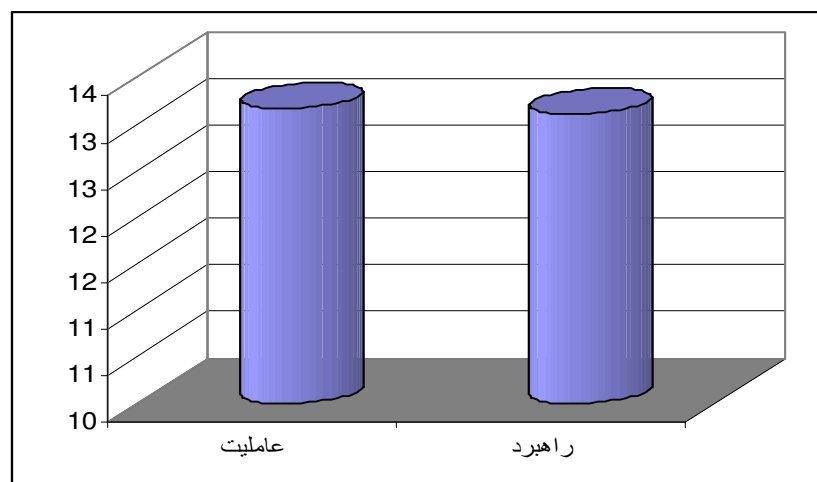
The results of table and graph 2 show that management sub-scale with the mean of 13.17 is a little higher than strategy sub-scale. Total mean of students' hopefulness is 26.2 with standard deviation of 3.8.

Table 3: Sub-scales of students' life satisfaction

Life satisfaction scale	mean	Standard deviation
family	32.22	6.14
friends	39.39	8.11
school	35.22	7.47
Life environment	38.19	8.49
self	29.52	6.58
Total score of life satisfaction	**174.53**	**30.27**

Graph 3: Bar graph of students' life satisfaction mean comparison
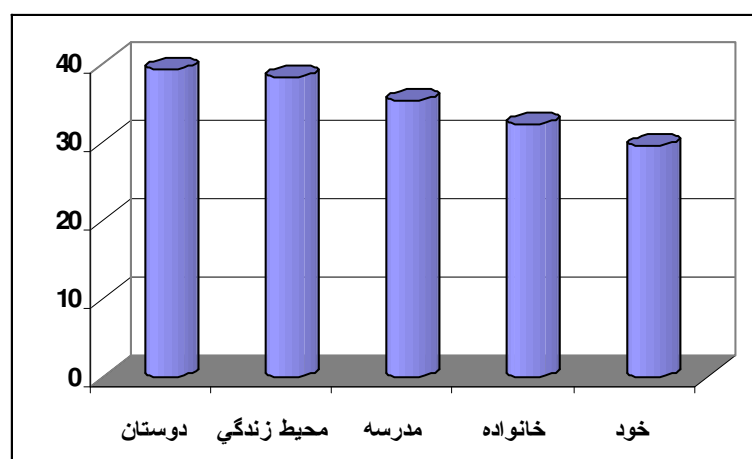
The results of table and graph 3 show that the mean of satisfaction with friends has the highest mean of 39.3. total mean of life satisfaction is 174.5.

b) Data Analysis

First Hypothesis

1. There is a positive relationship between hardiness (commitment, challenge, control) and students' life satisfaction?

Table 4: Indices and statistics of regression analysis between hardiness with students' life satisfaction

R	R Square	Modified R	SEM
.240	.058	.048	29.53

To explain and investigate the role of hardiness as independent variable, the results showed that hardiness has 0.240 correlation coefficient with students' life satisfaction and explains 5.8 of the variance of their life satisfaction.

Table 5: Regression analysis. Students' life satisfaction by hardiness

scale / source	Square sum	df	Square mean	F	Sig.
regression	15840.879	3	5280.293		
residual	258207.908	296	872.324	6.053	.001
Total	274048.787	299			

Analysis of observed variance (df=3, 296,f=6.05) show that students' hardiness is meaningful in explaining their life satisfaction ($P<0.005$).

Table 6: Regression variables

scale / hardiness	beta coefficient	Standard Beta coefficient		T ratio	sig
	B	Standard error	Beta		
Fixed value	156.982	12.135		12.936	.000
challenge	-.120	.402	-.018	-.297	.007
commitment	1.527	.380	.249	4.016	.000
control	-.742	.338	-.130	-2.199	.029

Result analysis and Beta of the above table show that the relationship and correlation between students' hardiness sub-scales and their life satisfaction is different. Regarding Beta coefficient of table 6, it is resulted that among sub-scales of hardiness, challenge and control have negative meaningful relationship with life satisfaction ($P<0.005$). Commitment has a positive relationship with students' life satisfaction and statistically meaningful. So the relationship between students' life satisfaction and their hardiness is supported.

Second Hypothesis

1. There is a positive relationship between hopefulness (management, strategy) and students' life satisfaction.

Table 7: Indices and statistics of regression analysis between hopefulness and life satisfaction

R	R Square	Modified R	SEM
.493	.243	.237	26.62689

The results show that hopefulness has 0.493 coefficient correlation with life satisfaction and explains 24.3 of the variance of their life satisfaction.

Table 8: Regression analysis. Students life satisfaction by hopefulness

source \ scale	R square	df	Mean of squares	F	Sig.
regression	66117.828	2	33058.914	46.628	001/0
Residual	206316.475	291	708.991		
total	**272434.303**	**293**			

Analysis of observed variance (df=2,291.f=46.6) showed that students' hopefulness is meaningful in explaining their life satisfaction (P<0.005)

Table 9: Regression variables

hopefulness \ scale	Beta coefficient		Beta	ratio t	Sig
	B	Standard error			
Fixed value	73.086	10.784		6.777	.000
management	4.601	.870	.335	5.289	.000
strategy	3.124	.926	.214	3.375	.001

Result analysis and Beta of the above table show that the relationship and correlation between students' hopefulness sub-scales and their life satisfaction is positive. Regarding Beta coefficient of table 9, it is resulted that the relationship between hopefulness sub-scales and students' life satisfaction is positive and statistically meaningful (P<0.005). so the relationship between students' life satisfaction and their hopefulness is supported.

Conclusion and Discussion

Regarding the relationship between hardiness and life satisfaction, the results of the present research are in line with some previous domestic studies like Jamhari.F (1380), Haqiqi et al (1381), Besharat et al (1387), Rudsari (1387), Matlabzadeh (1383), Bakhshipour (1387), Bayani et al (1386), Shirmohammadi et al (1389), Sadeqi (1388) and foreign researchers like Shird.M, Goldby,J (2007), Medi,S.R (2006), Gunla.I (2004), John (2000), Si Ward,P (1997), John.d (2003) and Medi et al (2007).

Besharat, Rezapour and Karimi (1387) showed that there is a positive relationship between hardiness and psychological well-being and educational success and a negative relationship between hardiness and incompetence. Hardiness through supporting active confrontation strategy, increasing individuals' confidence to their abilities in facing with stressful conditions, increasing self-confidence and commitment, control and challenge mechanisms assists person's psychological health and educational success. The results of Haqiqi, Attari, Rahimi and Soleymainnia (1381) showed that there is a positive relationship between hardiness and its sub-scales and psychological health and commitment is the best predictor of psychological health. In his study, Rudsari came to conclusion that life satisfaction and social support predict psychological health meaningfully and commitment correlated meaningfully with higher psychological health, life satisfaction and social support. Matlabzadeh concluded that the rate of severity of father's injury, parents' education level, parents separation and family economic level predict life satisfaction and well-being. Also he found that recognition of stress disorder in injured soldiers predict more powerfully their children life satisfaction and well-being. The results of Bakhshipour (13870 showed that problem solving styles and religious approach effect meaningfully in stress decline and modification and student life satisfaction. Bayani et al (1386) came to conclusion that there is a negative meaningful relationship between dimensions of psychological well-being and general health and happiness. The results of Shirmohammadi et al results showed that there is a positive relationship between hardiness and its sub-scales and life satisfaction. Hopefulness was the most powerful variable in predicting and explaining life satisfaction. The results of Sadeqi (1388), showed that there is a positive meaningful relationship between optimism and

psychological well-being. There was a meaningful difference between male and female students' optimism rate. Jamhar (1380) concluded that each three indices of hardiness had a reverse relationship with inclination to depression and anxiety separately and collectively.

The results of Shird and Goldby (2007) showed that students' scores in commitment scale and general score of hardness had a positive meaningful relationship with educational success. Medi, S.R (2006) stated that hardness influences students' health and educational performance. Gunla.I (2004) concluded that there was a medium relationship between hardiness and compatibility and hard persons had higher scores in compatibility. The results of John.D (2000) claimed that students with high hardiness didn't face with more positive events but are faced with less negative ones meaningfully. Also students with low hardiness used more reactive-avoiding treatment methods meaningfully in comparison with highly hardiness students. the results of Si Ward.P (1997) showed that high hardiness can assist individuals in adapting and dealing with problems and hardiness indices (commitment, control, challenge) are acquirable. John (2003) concluded approved that hardiness had a modifying role in the relationship between stress and futility and hardiness had a positive effect on educational success. Medi,S.R, Kushaba, Persico, Harvery and Bliker (2007) found that hardiness of university students had a negative correlation with clinical scales even when the negative emotionality is controlled, this correlation remained. So hardiness is not equal with negative emotionality. In explaining the results of the first research hypothesis, first the important point should be noted that it seems that efforts of all human beings are for reaching satisfaction feeling, well-being and prosperity. In fact it can be said that satisfaction feeling is one of the most important supports of individuals to face with problems. We are faced with some problems in social and personal life that reacting to these problems directly influences our lives and bring us the satisfaction we desire. So satisfaction of individuals' life is one of the needs of societies because life satisfaction creates feelings of all-out comfort and confidence to present and future time. On the other side, to form economic prosperity, investment and programming every other kind of social activity, a least of confident and comfortable conditions is needed. This security shows people's satisfaction of social life. Beside that feeling of satisfaction is a need, also it is a very important factor in development and progress of every country.

On the other side, directly and indirectly, there are lots of effective factors on individuals' life satisfaction. The results of the present research showed clearly that one of the subjects which influences teenage students is the important issue of hardiness. It is a personality trait which is considered as a factor in promoting psychological health. In Medi and Kubasa view, hardiness is the ability of proper understanding of outside conditions and proper decision making about the self (cited in Jamhari, 1384. Hardiness is afactor which causes self-controlling of emotions and deviates stress. It seems that hardiness among teenagers wspwcially girls makes a special internal approach which significantly influences the ways to face with different problems of the life. It causes that individuals look at the problems with a wider view and more realistically. hardiness gives people more sources to answer the stresses. In other words, hardiness is a basic feeling of control which provides the individuals useful strategies to face with outer crises. Hardiness is an adjective which is influenced mostly by individuals' cognition and understanding. Everybody's understanding of the self and the ways to review past experience and evaluate the self are among the factors which influence on hardiness. Individuals' understanding of their emotions and the amount they have connection with them, the ability to recognize the emotions as they occur and the ability to control them all the time is very necessary for psychological insight and self-understanding. So hardiness shows individual's understanding of around world and his ability in making efficient personal decision.

So it seems that hard persons have special internal viewpoint. This viewpoint helps them to insert special methods in dealing with life problems and their relatives and friends. Hard persons mostly see life occurrences interesting, various, didactic and challenging. They regard life events realistically with a kind of high-mindedness. They have more optimistic approach toward all life dealings. Probably this optimistic view increase hard persons' tolerance against undesirable and unexpected events. Some researchers believe that if a person is capable emotionally, he can face with life challenges better and regulate emotions to have a higher psychological health. Generally emotional

capabilities predict life's behavior and outcomes. So they are very important for teen girls' psychological health. The results of previous studies which some of them was mentioned before show that hardiness in high levels in addition to increasing teenagers' social skills and removing their stress, has a significant role in prediction of their individual and group achievements. So life satisfaction is a necessary reality for individuals and society. It has a more extreme importance for teenage girls in comparison with other groups because they should prepare themselves to take hard responsibilities of life as future mothers. However life satisfaction depends on personal conditions of theses teenagers to some extent, there are lots of other social factors which have more powerful roles in its increase and decline.

Regarding the relationship between hopefulness and life satisfaction, the results of the present study are in line with some parts of domestic researchers like Meymandi and Barqmadi (1389), Noqani et al (1389), Yusofnejad and Peyvastegar (1390) and foregn researchers like Benzar et al (2005), Goldby and Shird (2004), Lindforce et al (2007), Torino et al (2007), Salesman et al (2005) and Akliz Kazrin (2009).

Meymandi and Barghmadi (1389) found that four main domains of worshippers including doing the obligations, recommended religious percepts, membership in religious groups and mediating religion in decision making and selection had meaningful relationship with life satisfaction. Noqani et al (1389) resulted that there is a meaningful relationship between social capital and life satisfaction. Yusefnejad and Peyvastegar (1390) found that there is negative relationship between emotional deprivation, social seclusion, fault, shyness, defeat, incompetency, disease or loss susceptibility, obeisance, altruism, emotional apprehension, obstinate criteria, excessive criticism, self-controlling and inadequate self-discipline with life satisfaction. The results of Benzar, Divani and Lerry (2005) showed that there is a high correlation between psychological health, hardiness and social support. Multi-regression analysis showed the independent effect of this factor on psychological health. Goldby and Shird (2004) came to conclusion that national teams sportsmen had meaningfully higher scores in three scales of hardiness in comparison with their fellowmen. Lindforce et al (2007) understood that life satisfaction had correlation with family and individuals factors like social support and familial problems. Life satisfaction correlated with men physical work and women's health. Turino et al (2007) showed that religious beliefs lead to improvement of health, life quality and life satisfaction. Salesman et al (2007) investigated the relationship between religion and spirituality and psychological compatibility with interfering role of optimism and social support. They found that the relationship between internal religion and life satisfaction was influenced by optimism and social satisfaction. Also a relationship was shown for religion in compatibility. It was specified that internal religion and benediction acceptance had relationship with life satisfaction but external religion didn't have relationship with life satisfaction. Akliz Karzin (2009) found that dimensions of being religious had meaningful relationship with life satisfaction. Religious persons were happier and had more positive view.

As the results of the present study showed, the issue of high levels of hopefulness among teenagers has a significant role in their life satisfaction. As it's been emphasized before, hope has been defined among individuals as a mentality focused on goal. It means that they can provide the leading ways to desirable goals which is related mentality to these ways and needed motivation to use these ways. So hopefulness is a very important structure in individuals' life because those who have high levels of hopefulness beside having a successful past experience in facing with stressful stimulators and achieving their goals have more positive emotions and interest and confidence. Inversely those who have lower hopefulness level have often unsuccessful confrontation with stressful stimulators and they have more negative emotions.

Schneider et al (1991) view hope as a cognitive set based on achievement feeling from different sources (goal-focused energy) and ways (programming to achieve goals). They consider hope as a positive motivational state which is made by the feeling of source interaction (goal-focused energy) and success ways (programming to achieve goals). So hope or goal-based thinking has been formatted from two related parts including thinking ways and thinking sources. Thinking sources reverberate individual's capacity to produce cognitive ways to achieve the goals and thinking sources include the thoughts defined by individuals about their abilities and capacities to pass selected ways and achieve

goals. Goals can be achieved through source mixing and ways. If each of these two cognitive elements is not present, reaching to goals is impossible.

Generally concluding the present study, it can be said that the society creates the conditions that can guide teens to gain their wishes. On the other side it provides the conditions that individuals can have mutual interaction with those who provide him with feeling of comfort, security and confidence for a proper life. So generalizing the presented topics, this result can be claimed that satisfaction in the young and teenage lives is a mixture of personal and social conditions which shows positive approaches toward the world and environment where teenager lives in. life satisfaction, well-being feeling, mutual trust and commitment feeling are all in one cultural cluster showing teenager's view toward the world and the self. Low life satisfaction level among teenagers is related to their negative approaches toward society to some extent. Probably the main reason of this condition is the situations which society provides for individuals through goals fulfillment and the security feeling caused by goals fulfillment. So it can be resulted that security feeling caused by needs satisfaction and goals fulfillment are among basic factors which develop life satisfaction among teenagers and different groups of society.

Practical Suggestions based on Study Results

The following suggestions are provided based on the results of the present study:

1. As the results of the present study showed, hardiness is a personality trait which is a factor in the promotion of teenage girls' life satisfaction. It is a mixture of beliefs about the world and the self which immunizes the individual against internal and external forces. This structure propels individuals in hard conditions and assists him to pass menacing events with higher levels of success. Based on the mentioned features, attention and emphasis on hardiness invigorating mentality and consolidating hardiness elements including challenging mentality, commitment and controlling hardiness will help female students to confront with stressful life conditions to travers their life road in menacing situations.

2. As it was marked, teenagers' hardiness had tight relationship with their life satisfaction which is originated from concepts like having goal and meaning in life, worthiness of enthusiastic and interesting life, power and responsibility of personal freedom and selection, importance of mind experience and effective role of individuals in making the society. Since hard persons face better with stressful conditions, probably they are less distressed and worried when confronting with these events. So it is emphasized that education institution in addition to familiarizing female students with hardiness mentality, prepare them for appropriate and more useful management of the society through education and introducing them with uses of hardiness.

3. As it was mentioned, important factors like personality traits, environmental factors, religious and economic approaches and other factors specially gained from this study like social ones including gaining social status, rate of social participation and relationships and feeling of social security are preconditions of social well-being. Basic approach in social well-fare is a multi-dimensional approach in social, economic and political aspects. Also social satisfaction is active and preventive; however it is followed by looking to past and non-performed covering of social problems.

4. Regarding the importance of satisfactions, some ways should be found to increase it. so some indices like feeling social security, social status, the rate of social participation and social relations are necessary on behalf of authorities because these variables had the highest correlation coefficient with the feeling of having social satisfaction and disregarding them leads to increase of dissatisfaction and split of individuals of the society from each other. The results show that the more people become worried about general and social conditions, seek individualism and try to invest for their own future and think about their social security. So pluralistic mentality is declined which decreases social and political trust and finally leads to a society with high anomaly and disturbance. So regarding Iranian society which is developing, not paying attention to each of these indices can act as a barrio in having the feeling of social satisfaction.

5. If we want to look at the topic from other side, it should be noted that hopefulness toward future and other indices as social capital of the country beside being considered as pre-condition of social development, they are regarded as development results and people's possession of satisfaction. So noting this social capital is like emphasizing material well-fare.
6. So different aspects of well-fare of social groups especially the young group and their educational and cultural affairs should be programmed through needs recognition because in a society where teenagers don't have eagerness toward future can't claim to establish social satisfaction in its general meaning.
7. The results showed that participating in social and cultural activities have significant effects in making satisfaction feeling among individuals. So holding happy jovial social programs like camping, celebrations can cause the public to enjoy their lives more and conclusively have higher feeling of satisfaction.
8. So it is suggested to start greater activation of associations and scientific and cultural student core groups to participate in different student activities and programs. Not only it increases the rate of social participation and social relations of the students, but also provide the condition for increasing worthiness feeling, respect and style of social status and finally students' feeling of social security.
9. Like other studies the present research had some limitations. It was tried that needed suggestions and guidance of professor pave the way for other researches.
10. Also doing studies in this field regarding life satisfaction in all social, economic, cultural and political aspects can be very useful in reaching deeper understanding of the society and very applicable for experts, programmers and social policy makers.

Research Limitations

Naturally every kind of research is faced with some problems which influence on procedures but modifying and decreasing the problems and changing them to proper opportunities firstly needs recognition of these problems and limitations. Some limitations of the study are mentioned here. In Iran research and investigation hasn't a celebrated place like other countries facing with some problems in human and social sciences fields. In Iran there is a kind of conservativeness and caution even among educated clusters which does not assist researchers. When investigations are about job and income, conservative mentality becomes clearer. So this research like other investigations had some limitations and problems in performance like conjoining with heads of schools to collect data and gaining needed information about statistical society and it should be tried to reach the study purposes through guidance of assistant professors.

1. Because of high number of questionnaires, some of the subjects didn't complete them and researcher deleted incomplete ones. Also this problem was obviated significantly through high number of selected sample.
2. The shortage of domestic and foreign studies about application of this test in different researches.
3. However the adapted scale in this research has six sub-scales claiming to measure individuals' hopefulness rate and since hopefulness has different definitions from different scholars and everybody has a special understanding of hopefulness depending on his theoretical approach, so hopefulness thinking may have other factors which are not considered here.

References

[1] Shaeban Izikan.s (1385). Comparison of hardiness anger (stating, controlling, experiencing) with blood pressure patients and healthy individuals. M.A. thesis. Tarbiat Moallem university

[2]   Argail.M (1382). Happiness psychology. Translated by Masud Gohari, Hamid Taherdoost, Hossein Palahang and Fatemeh Bahrami. Isfahan: jahade danesghgahi publication.

[3]   Arianpour Kashani.M. (1380). One volume advanced dictionary of Aryanpour (English to Persian). Tehran. Jahan rayaneh.

[4]   Azmudeh.P (1383). The relationship between religious orientation with hardiness and happiness of Shahid-beheshti university. M.A. thesis. Educational sciences and psychology faculty. Shahid Beheshti university.

[5]   Atkinson. R and Haligard.Ar (1996). Psychology field. Translated by Rafiei.M and Smiei.M and Arjmand. Tehran. Roshde Tarikh publication

[6]   Argail.M (1382). Happiness psychology. Translated by Masud Gohari, Hamid Taherdoost, Hossein Palahang and Fatemeh Bahrami. Isfahan: jahade danesghgahi publication.

[7]   Beyzai.Mohammad Hossein (1387). Investigation of the relationship between personality types, hardiness, stress and coronary heart diseases in heart coronary patients and healthy individuals. M.A thesis. Tarbiat Modarres university.

[8]   Bayani.E and Gudarzi.H and Kuchaki. E (1386). The relationship of well-being dimensions and general health. Knowledge and research in psychology. Azad university. Khuzestan Branch. No.35-36.P. 153-146.

[9]   Jamhari.F (1381). Investigation of the relationship between hardiness and inclination toward depression and anxiety among student men and women of Tehran city. Docctoral dissertation. Allameh Tabatabai university.

[10]   Jamhari.F (1380). Investigation of the relationship between hardiness and inclination toward depression and anxiety among men and women of Tehran universities. Docctoral dissertation. Allameh Tabatabai university.

[11]   Kiamarsi.Abolqasemi.E (1385). Hardiness psychology. Ardebil: Islamic Azad university publication.

[12]   Meymandi.M and barghmadi.M (1389). The relationship between performing religious beliefs and life satisfaction among elders. Iran elders magazine. Fifth year. NO.15. P.87-93

[13]   Hiubner et al .semantics. translated by Farideli.E. Tehran university publication

[14]   Yusefnejad.M and Peyvastehgar.M (1390). The relationship between life satisfaction and original incompatible pseudo-plans in students. knowledge and research in psychology quarterly. Twelfth year.No.2. P.55-65.

منابع خارجی :

[1]   Chan,D.W.(2003).hardiness and its Role in the stress burnout Relationship Among prospective Chinese teachers in hong kong.Journal of teaching and techer Education.19:pp381-395

[2]   Glaser, J.K. Glaser, R.(1990).stress and immune function in Humans , in Ader, R, Felten, D.L.Cohen,N(Eds), psychoneuimmunology, Ed2, new York, Academic press.

[3]   Maddi<S.R.khoshaba,D.M.persico,M.Lu,1.harvery,R.bleecker,F.(2007).the personality construcat of hardiness,II:Relationships with comprehensive tests of personality and psychopathology.journal Research in personality,36:pp72-85.

[4]   Maddi,s.R.kobasa,s.c.(2005).the hardy Executive: Health under stress. Ho,ewood,IL:Dow jones-Irwin.

[5]   Seligman , M.& Csikszentmihalyi, M. (2000). Positive psychology : Anintroduction American psychologist, 55, 5-14.

[6]   Seligman , M. E. P.(1991)learned optimism: newyork: knopf.

[7]   Seligman , M.E.P., Linley, P.A.& Joseph, S. (2004). POSITIVE PSYCHOLOGY IN PRUCTICE. Hoboken, new jersey : john

The Relationship Between Earnings Quality and Some Aspects of Corporate Governance

Fatemeh Ahmadi
Corresponding Author, Accounting Department
University of Islamic Azad Branch of Ilam, Iran
E-mail: fatemehahmady60@yahoo.com
Tel: +98-918-8404699

Abstract

This study examined the relationship between earnings quality and corporate governance. Two measures are intended to measure earnings quality. First measure of earning quality is the ratio of cash flows from operating activities to operating earnings and the second measure of earning quality is measuring of the quality of working capital accruals that had proposed by (Dechow and Dichev, 2002). The relationship between two features of corporate governance means transparency of financial information and structure of the board of directors to earnings quality was studied. The structure of the board of directors was investigated in two dimensions: one the number of irresponsible board members and other percentage of managerial share ownership. The results of Hypothesis test showed that there are positively significant relationship between earnings transparency and earnings quality. However, except the second measure of earnings quality, that had weak relationship with ownership percentage of board members, there was no significant relationship between measures of earnings quality and other features of structure of the board of directors.

Keywords: Quality of earnings, accruals quality, earnings transparency, board structure

1. Introduction

Corporate governance is including the notions that there is no single definition for it. Different scholars have different definition for corporate governance this definition potentially cover the full scope of activities that directly or indirectly affect the company's financial health. Because of firms rely on all law rights of financial supplier such shareholders, corporate governance is defined as a way of guiding, monitoring and control. On other words, in order to monitor the decisions and actions of senior managers to ensure that their activities are compatible with the specific interests of shareholders and other stakeholders, corporate governance will be provide (Lee, 2006).

According to another definition, corporate governance debate about the ways in which assure suppliers of finance to corporations that they will achieve to return on their investment. (Shleifer and Vishny, 1997). One of the features of corporate governance is financial information quality. Financial information quality means transparency of profits and timely disclosure and more. This study examines the relationship between corporate governance and earnings quality. Two features of corporate governance, transparency of financial information and the structure of board of directors has been considered that transparency of financial information have been measured by transparency of profits and structure of board of directors have been measured by measuring of percentage of board members

property and the number of responsible and irresponsible managers. Two criteria were used to measure earnings quality. The first criterion is based on the ratio of cash flows from operating activities to operating profit (Harris, 2000) and the second criterion is based on the quality of working capital accruals (Dechow and Dichev, 2002).

2. Quality of Earnings

Earnings quality is an important criteria of the financial health of the business unit and is a multidimensional concept and no single meaning (Bellovary, Giacomino and Akers, 2006). Teets stated that some people defined earnings quality as the ability of accounting earnings to reflect economic events of interest to know (Teets, 2002).Pratt defined earnings quality based on differences between reported net profit and real profit based on Hix's opinion (Pratt, 2002). Penman measures earnings quality with regard to future earnings and current earnings (Penman, 2003).

Different measures of earnings quality show s that a favorable benefit is one that to portray the cash flows (Harris et al, 2000; Penman 2001, Francise et al, 2004). Kormandi and Lipe, were calculated stable earnings coefficient by use of regression between current year earnings and profits earned last year. If coefficient is much closer to one or even greater than, indicating greater stability of earnings. (Kormandi and Lipe, 1987). According to Wysocki, measure of earnings quality is to be close to cash flow. (Wysocki, 2004). Leuz, Nanda and Wysocki Burgstahler, Hail and Leuz , using absolute amount of working capital accruals as a measure of earnings management and its balancing through operating cash flows, were introduced smoothed earning .In addition, they calculated smooth earnings by use of measure of standard deviation of operating earnings from operating cash flows (Leuz, Nanda and Wysocki 2003; Burgstahler, Hail and Leuz 2004). According to Bowen, Rajgopal and Venkatachalam smoothed earning calculated by the standard deviation of operating cash flows divided by the standard deviation of the profit. Large amounts of smoothing indicating lower earnings quality. (Bowen, Rajgopal and Venkatachalam, 2003).

Assessment of the quality of earnings helps users of financial statements to judge about the current interest rate and can predict the future. (Deloitte and Touche, 2004). Teets has identified three types of decisions that have impact on the quality of earnings:
1. Decisions that to be applied by the framers of the standard.
2. Management decisions about the choice of accounting methods. For example, the First –In ,first-Out method (FIFO) for inventory valuation in the period of rising prices, or straight-line depreciation method that has results in faster recognition of profit (Dechow and Skinner, 2000).
3. Judgments and estimates that to be used by management to apply accounting methods (Teets, 2002).

3. Corporate Governance

In recent years, corporate governance becomes an essential and dynamics aspect of business and attention to it is growing exponentially. Improvements in corporate governance will be applied at the global level. International organizations such as the Organization for Economic Cooperation and Development provide international acceptable standards in this case (Hassas Yegane, 1384).

Corporate governance is applicable as a reference feature, and policy makers can use it in the legal and regulatory framework for company's base on economic, social, cultural, legal conditions. According to Ashbaugh, corporate governance is a wide range of solutions that reduce agency risk through increasing of monitoring of management action, limiting the opportunistic behavior of managers and improving the flow of information. From his perspective some characteristics of corporate governance are as follows: (Ashbaugh, et al 2004)
1. **Transparency of financial information**: corporate governance should be become cause of transparent, and accurate timely disclosure of financial position and performance of the company.

2. **Structure of ownership**: corporate governance should be determine measure of ownership and number of shareholders to the appropriate ownership structure in company to be determine.

3. **Shareholders' rights**: corporate governance should protect and facilitate the exercise of shareholders' rights.

4. **Board structure**: corporate governance must be determine members of the Board of Directors, number of irresponsible managers well.

Part of firm's operations is concerned to agency relationship between shareholders and managers. In fact, the separation of stock ownership and management control over the operations of the company's may lead to a conflict of interest and agency costs arise from conflicts of interest between managers and shareholders.

Corporate governance mechanisms can reduce earnings management opportunities and enhance the quality of earnings. It is expected that increasing the percentage of shares owned by members' sensitivity of management to reported profits optimistically increased. So, must exists the same relationship between the percentage of shares owned by board members and the quality of earnings. Therefore, expect that with increasing of stock ownership percentage of Board members, the earnings quality increases.

4. Literature of Review

McCinnell and Servaes: investigators were found a negative relation between the percentage of stock ownership of board members and Kiwi Tobin as a measure of firm performance. In other words, increasing the percentage of shares owned by board members, monitoring would change from foreign shareholders to managers and managerial stock ownership and corporate performance would be weaken and this is because of increasing cost of management agency. They did not any liner relationship so were examined non-linear relationship between the percentage of shares owned by members of the board and earnings quality and found that there is a negative linear relationship between the percentage of stock ownership of board members and the quality of earnings. In this study the quality of earnings was measured through accruals (McCinnell and Servaes, 1990).

Jensen: He stated in his research that increase of property percentage help to managers and shareholders become share. So, when the percentage of shareholders stock ownership increases, firm performance increases by reducing in agency costs.

Beasley: He was analyzed the relationship between the composition of board of directors and fraud in financial statement. In this study, he was examined this issue that more members of the board, reducing the possibility of fraud in financial statement. In this study also examined the audit committee and the concluded that the audit committee has no important effect on the likelihood of fraud in financial statements (Beasley, 1996).

Young: His results about earnings management showed that the number of irresponsible managers and possibility of management of abnormal accruals to avoid reporting of losses or reduced profits are inversely related. (Young, et al, 2000)

Dechow and Dichev: These researchers have been investigated relationship between the quality of accruals and persistence of earnings. Their empirical measure of the quality of accruals was the regression of changes in working capital based on operating cash flows in past, present and future. Whatever the standard deviation of regression residuals is less, the quality of accruals is high. The results showed that there was a positive relationship between the quality of accruals and earnings persistence (Dechow and Dichev, 2002).

Cameron: He has been investigated the relationship between earnings quality and information asymmetry. Previous research has demonstrated that increased earnings quality, does not reduce information asymmetry among investors (Bushman, 2001, Zhang, 2000). In this research, with an emphasis on Kim and Verrecchia's earnings quality theory (Kim and Verrecchia, 1991) and based on

the experimental tests, a large sample of companies has been characterized that by an increase in earnings quality, reduced information asymmetry among investors (Cameron, 2003).

Richardson: He selected a sample of U.S. companies and investigated that whether short seller investors understand information embedded in accruals (earnings quality indicator) and whether employ it in their predictions? The results showed that the short sellers do not use of the information embedded in accruals, on other words, they do not consider the earnings quality (Richardson, 2003).

Ashbaugh, et al: They investigated the effect of features of corporate governance on the cost of equity. These features were included of the quality of financial information, ownership structure, shareholder rights, and board structure, respectively. The results showed that more reported abnormal accruals and opaque earnings will raise the cost of equity (Ashbaugh, et al, 2004).

Garmaise and Lui: They have predicted that the use of incorporate governance ineffectively coupled with bad management, will increase companies systemic risk. (Garmaise and Lui, 2004).

Kirschenheiter and Melumad: They were examined the relationship between earnings smoothing and earnings quality. In this study it is assumed that management knowledge is good, in other words, he is able to identify the permanent and transitory income. Then the model was defined for high earnings quality. The results show that income smoothing has higher quality (Kirschenheiter and Melumad, 2004).

Ashbaugh,et al: They were investigated the relationship between corporate governance and capital costs. The risk factors were also considered. The results indicated that higher quality of reporting reduces anomalies risk, beta and cost of equity, and also companies that best meet the requirements of corporate governance had represented lower agency risk, and less stock costs (Ashbaugh, et al, 2006).

5. Research Hypotheses

H1: There is significant positive relationship between earnings quality and earnings transparency.

H2:: There is a significant positive relationship between the quality of working capital accruals and earnings transparency.

H3: There is a significant relationship between earnings quality and the percentage of managerial share ownership.

H4: There is a significant relationship between the quality of working capital accruals and the percentage of managerial share ownership

H5: There is a significant relationship between earnings quality and the number of irresponsible managers of the board.

H6: There is a significant relationship between the quality of working capital accruals and number of irresponsible members of the board.

6. Methodology of Research

This research is a background investigation of the event. Because of this study examines the existence of relationship and correlation between variables using regression equations therefore is a kind of correlation. In order to collect the required data, TADBIR-CD and SAHRA software and also Exchange site were used.

7. Measurement of Variables
7.1.1. Independent Variables

1. **Earning Transparency (ET):** Is the first independent variable in this study that is calculated based on follow regression.(Ashbaugh, et al, 2004).

$$R_{i,t} = \alpha_0 + \alpha_1 NIBE_{i,t} + \alpha_2 LOSS_{i,t} + \alpha_3 NIBE_{i,t} * LOSS_{i,t} + \alpha_4 \Delta NIBE_{i,t} + \varepsilon_{i,t}.$$

$R_{i,t}$: yields of market

$NIBE_{i,t}$: The ratio of net earnings before extraordinary items to market value of common stock at the beginning of the period.

$Loss_{i,t}$: If NIBE become negative is equal to one and otherwise is zero.

$\Delta NIBE_{i,t}$: The ratio of changes in net earnings before extraordinary items to market value of the common stock at the beginning of the period.

$\varepsilon_{i,t}$: Is regression residuals that its square is represents earnings transparency index, more higher residuals means lower earnings.

   2. The percentage of managerial share ownership (MSO):

The percentage of managerial share ownership defines as ownership of percentage of stock in firms that use to obtain a part of management in firm. In this study firm in management of business unit defined as the ability of selecting of one member as a board of directors and calculated by dividing of percentage of shares participated in the meeting to number of board of director plus 1.Of course this percentage is not same in all companies. Because the percentage of shares participated in the meeting and in continues years are not same in different companies, so, at first the percentage of shares participated in the meeting was determined and then percentage of managerial share ownership was calculated. Then this percentage was test again. Using the accounted standard, the percentage of managerial share ownership in different companies in sample was extracted.

   3. Number of irresponsible managerial Board members (DIR):

To measure the number of irresponsible directors, the number of irresponsible directors in board of directors in firm during one year is required.

7.1.2. Dependent Variable

   1. Earnings quality ($EQ_{i,t}$): Is dependent variable in this study and the two criteria were used to measure it.

The first measure of earnings quality is the ratio of cash flows from operating activities to earnings operating (Harris, 2000).

$$EQ = \frac{CFO}{OE}.$$

   2. The second measure: the second definition of earnings quality is the quality of working capital accruals and are calculated based on the following regression (Dechow and Dichev, 2002, McNichols, 2002).

$$TCA_{i,t} = k_0 + k_1 CFO_{i,t-1} + k_2 CFO_{i,t} + k_3 CFO_{i,t+1} + k_4 \left(\Delta Sales_{i,t} - \Delta AR_{i,t} \right) + k_5 PPE_{i,t} + \varepsilon_{i,t}.$$

$TCA_{i,t}$ is the sum of working capital accruals that are measured using the following equation:

$$TCA_{i,t} = \frac{\Delta CA_{i,t} - \Delta CL_{i,t} - \Delta CASH_{i,t} + \Delta STDEBT_{i,t}}{\text{Average of book value of total assets in years } t-1 \text{ and } t}.$$

$\Delta CA_{i,t}$: Change in current assets during year's t-1 and t

$\Delta CL_{i,t}$: Change in total current liabilities during t-1 and t

$\Delta CASH_{i,t}$: Change in cash during the yearst-1 and t

$\Delta STDEBT_{i,t}$: Change in the current portion of loans received during the period t-1 and t

$CFO_{i,t}$: operating cash flow divided by the average of book value of total assets in year's t-1 and t

$\Delta Sales_{i,t}$: Change in sales revenue during the year's t-1 and t, divided by the average of book value of total assets in year's t-1 and t

$\Delta AR_{i,t}$: Change in receivable accounts during year's t-1 and t, divided by the average of book value of total assets in year's t-1 and t

$PPE_{i,t}PPE_{i,t}$: Net value of tangible fixed assets in year t, divided by the average of book value of total assets in year's t-1 and t

$\varepsilon_{i,t}$: Residuals from the regression. Standard deviation of this residuals over the years t-3 to t, is measuring index of the quality of working capital accruals. However standard deviation is much higher, the quality of working capital accruals will be lower. Then is multiplied in number -1 and with new standard, however the higher standard deviation, its quality will be higher (Francis, et al, 2004).

7.1.3. Control Variables

1. **Size** (size of company)**:** is natural logarithm of book value of assets at the end of the fiscal year.
2. **CFO:** Operating cash flow divided by the average of book value of total assets during years t-1 and t.
3. **LEV:** Is the ratio of debt, and is equal to total debts divided by total assets.

8. Population

The participants of this study were accepted company in Tehran Stock Exchange and samples of this study were selected for financial periods of firms during 1386 to 13890 based on below features:

1. If their financial year lead to end of March.
2. At the end of 1383, the company name will be listed on the stock boards.
3. The companies don't have loss.

Accordingly, the population of this study was consisted of 120 companies. Spss software has been used for data analysis.

9. Testing of Research Hypotheses

For analysis of hypotheses in this study and based on each hypothesis, multiple variable regression method has been used. Also, F-test was used to determine the significance of the whole model and T-test was used to evaluate the significance of regression coefficients.

To investigate the first and second hypotheses, follow regression was used.

$$EQ_{i,t}^x = \beta_0 + \beta_1 ET_{i,t} + \beta_2 Size_{i,t} + \beta_3 CFO_{i,t} + \varepsilon_{i,t}.$$

To investigate the third and fourth hypotheses, follow regression was used.

$$EQ_{i,t}^x = \beta_0 + \beta_1 MSO_{i,t} + \beta_2 Size_{i,t} + \beta_3 CFO_{i,t} + \beta_4 LEV_{i,t} + \varepsilon_{i,t}.$$

And for the fifth and sixth hypotheses follow regression were designed regression.

$$EQ_{i,t}^x = \beta_0 + \beta_1 DIR_{i,t} + \beta_2 Size_{i,t} + \beta_3 CFO_{i,t} + \beta_4 LEV_{i,t} + \varepsilon_{i,t}.$$

The results of hypotheses test showed in below:

Table 1: Coefficients and t-statistic of first hypothesis

	B	Std. Error	t-statistic	*p-value*	relation	Result of hypothesis
constant	0.2162	0.0153	4.1165	0.0000		
$ET_{i,t}$	1.6115	0.0124	4.3461	0.0063	positive	confirmed
$Size_{i,t}$	0.3358	0.0085	2.6471	0.0019	positive	
$CFO_{i,}$	0.4123	0.0166	5.3817	0.0000	positive	

Adj. $R^2 = 0.178$

Table 2: Coefficients and t-statistic of second hypothesis

	B	Std. Error	t-statistic	*p-value*	relation	Result of hypothesis
constant	0.4679	0.0091	3.7165	0.0000		
$ET_{i,t}$	1.3265	0.0188	4.8513	0.0021	positive	confirmed
$Size_{i,t}$	0.5963	0.0284	3.1887	0.0053	positive	
$CFO_{i,}$	0.1329	0.0149	2.4632	0.0086	positive	

Adj. $R^2 = 0.155$

Table 3:   Coefficients and t-statistic of third hypothesis

	B	Std. Error	t-statistic	p-value	relation	Result of hypothesis
constant	0.3415	0.0596	1.6176	0.5961		
$MSO_{i,t}$	0.0023	0.0011	2.623	0.0721	positive	
$Size_{i,t}$	0.0071	0.0086	1.132	0.0045	positive	Not confirmed
$CFO_{i,}$	0.0032	0.0048	2.0531	0.0073	positive	
$LEV_{i,t}$	-0.6492	-0.0341	-3.5381	0.0002	negative	

Adj. R^2 = 0.0996

Table 4:   Coefficients and t-statistic of fourth hypothesis

	B	Std. Error	t-statistic	p-value	relation	Result of hypothesis
constant	0.5284	0.1273	2.0927	0.0042		
$MSO_{i,t}$	0.0421	0.0617	3.741	0.0021	positive	
$Size_{i,t}$	0.0171	0.0256	2.351	0.0013	positive	onfirmed
$CFO_{i,}$	0.0561	0.0134	3.124	0.0000	positive	
$LEV_{i,t}$	-0.8921	-0.06719	-4.8145	0.0000	negative	

Adj. R^2 = 0.1672

Table 5:   Coefficients and t-statistic of fifth hypothesis

	B	Std. Error	t-statistic	p-value	relation	Result of hypothesis
constant	0.2418	0.0137	1.692	0.0011		
$DIR_{i,}$	-0.0031	-0.0065	-0.0038	0.0831	negative	
$Size_{i,t}$	0.0042	0.0131	1.157	0.0000	positive	Not confirmed
$CFO_{i,}$	0.8721	0.0478	3.7529	0.0007	positive	
$LEV_{i,t}$	-0.3185	-0.1523	-1.1831	0.0021	negative	

Adj. R^2 = 0.2823

Table 6:   Coefficients and t-statistic of sixth hypothesis

	B	Std. Error	t-statistic	p-value	relation	Result of hypothesis
constant	0.7015	0.0274	2.9721	0.0032		
$DIR_{i,}$	-0.0683	-0.0495	-0.0782	0.0943	negative	
$Size_{i,t}$	0.7629	0.1363	3.015	0.0005	positive	Not confirmed
$CFO_{i,}$	0.3615	0.07124	2.5831	0.0081	positive	
$LEV_{i,t}$	-0.7944	-0.5217	-2.0142	0.0007	negative	

Adj. R^2 = 0.2156

10. Conclusions

The purpose of this study was to examine the relationship between earnings quality and two features of corporate governance means transparency of financial information and the structure of board of directors. The structure of the board of directors were investigated in two dimension: one the number of irresponsible board members and other percentage of managerial share ownership Two criteria were used to measure earnings quality. First measure of earnings quality was the ratio of cash flows from operating activities to operating earnings and the second measure of earning quality was measuring of the quality of working capital accruals .Three variables control, size of company, cash flow operating activities and the ratio of debt were entered to regression models. In this regard the research hypotheses were developed based on literature of this study. The results of hypotheses test showed that there are positive significant relationship between both earnings transparency and earnings quality. While except the second criterion of earnings quality that had weak relation with percentage of managerial share ownership, there was no significant relationship between earnings quality and other features of board structure.

Resources

[1]   Ashbaugh, H. and D.W.Collins and R.Lafond, 2004, "Corporate Governance and The Cost of Equity Capital", *www.SSRN.com*.

[2]   Ashbaugh, H. and D.W.Collins and R.Lafond, 2006, "Corporate Governance, Risk and The Cost of Equity Capital", *www.SSRN.com.*

[3]   Beasley, M. (1996), 'An empirical analysis of the relation between the Board of Directors composition and financial statement fraud', *Accounting Review*, 71, 443-465.

[4]   Bellovary, J., D. Giacomino and M. Akers, 2006, "A Review of Bankruptcy Prediction Studies: 1930 to Present", *www.ebsco.com*.

[5]   Bowen, R., S. Rajgopal and M. Venkatachalam, 2003, "Accounting Discretion, Corporate Governance and Firm Performance", Working Paper, *www.ebsco.com*.

[6]   Burgstahler, D., L. Hail and C. Leuz, 2004, "The importance of Reporting incentives: Earnings management in European private and public firms", Working Paper, *www.ebsco.com*.

[7]   Cameron, Hooper, 2003, "Information Asymmetry and the Quality of earnings ", *www.SSRN.com*.

[8]   Dechow, P. and D. Skinner, 2000, "Earnings Management: Reconciling the Views of Accounting Academics, Practitioners and Regulators", *Accounting Horizons*, 14, 235-250.

[9]   Dechow, p. and I. Dichev, 2002, "The quality of accruals and earnings: The role of accrual estimation errors", *The Accounting Review*, No.77, pp 35-59.

[10]   Deloitte and Touche, 2004, "Quality of Earnings, Integrity and Quality: Quality of Earnings", *www.ebsco.com*.

[11]   Francis, Jennifer, Rayn LaFond, Per M. Olsson and Katherine Schipper, 2004, "Costs of equity and earnings attributes", *Accounting Review*, Vol 79, No.4, pp.967-1010.

[12]   Garmaise, M. and J. Lui, 2004, "Corruption, Firm Governance and the Cost of Capital", Working paper, *UCLA*.

[13]   Harris, T., E. Huh and P. Fairfield, 2000, "Gauging Profitability of the Road to Valuation", *Strategy Report*, Global Valuation and Accounting, Morgan Stanley Dean Witter.

[14]   Hasas yeganeh, Yahya, "Theoretical Foundations of Corporate Governance", *Journal of Accounting*, No. 168, 1384.

[15]   Jensen,M.c.(1993) 'The modern industrial revolution, exit and the failure of internal control systems'*, Journal of Finance*.

[16]   Kirschenheiter, Michael. and Nahum Melumad, September 2004, "Earnings' Quality and Smoothing", *SSRN Website*.

[17]   Kormendi, R. and R. lipe, 1987, "Earnings innovations, earnings persistence and stock returns", Journal of business, No.60, pp 323-345.

[18]   Lee, A. Tomas, 2006," Financial Reporting Corporate Governance", *Wiley*, p:20

[19]   Leuz, C., D. Nanda and P. Wysocki, 2003, "Earnings management and investor Protection: An international Comparison", *Journal of Financial Economics*, 69, 505-527.

[20]   Mathur, uc, 2005, corporate governance and business ethics. Text and Cases, First published, Macmillan India Ltd.

[21]   McCinnell,J.and Servaes, H.,(1990) "Additional evidence on equity ownership and corporate value" *Journal of financial Economics*,7,595-612

[22]   McNichols, M., 2002, "Discussion of the quality of accruals and earnings: the role of accruals estimation errors", *The Accounting Review*, 77, 61-69.

[23]   Penman, S., 2001, "Financial statement Analysis and Equity valuation", New york, MY: mcgraw- Hill/Irwin.

[24]   Penman, S., 2003, "Financial Statement analysis and Security Valuation", New york, MY: mcgraw- Hill/Irwin.

[25]   Pratt, J., P. Joos and S. Young, 2002, "Using deferred taxes to infer the quality of accruals", Working Paper, *www.ebsco.com*

[26]   Rahbari Kharrazi, M., "Investigatev and Evaluation of corporate governance in listed companies in Tehran Stock Exchange in comparison with other countries," Master's thesis, University of Allameh Tabatabai, 1383.

[27]   Richardson,S.,2003, "Earnings Quality and short sellers", *Accounting Horizons*,pp49-61.

[28]   Shliefer, A. and R. Vishney, 1997,"A Survey of Corporate Governance*", The Journal of Finance*, 52:737-783.

[29]   Teets, W. R. 2002, "Quality of earnings: An introduction to the issues in accounting education special issue", *Issues in Accounting Educa*tion, 17 (4), 355.

[30]   Wysocki, Peter D., 2004, "Discussion of Ultimate ownership, income management, legal and extra-legal institutions", *Journal of Accounting Research*, 42, 463-474.

[31]   Young, S., Peasnell, K. V., and Pope, P. F. (2000) "Board monitoring and earnings management: Do Outside Directors Influence Abnormal Accruals?" *www.SSRN.com*

In Search of Entrepreneurial Situational Leadership as a New Theory

Mohammad Reza Zali
Assistant Professor, The Faculty of Entrepreneurship
University of Tehran, Tehran, Iran
Email: mrzali@ut.ac.ir

Abstract

The purpose of this paper is to develop the entrepreneurial leadership theory in a contingency approach. Therefore the Entrepreneurial Situational Leadership Theory is developed and presented. This paper uses a narrative review of several papers of various publishers registered with Scopus, to investigate the evolution of leadership theories and entrepreneurial leadership research. The paper integrates Thornberry's descriptive model of Entrepreneurial Leadership Strategies with Entrepreneurial Orientation as Organizational Entrepreneurial Readiness. Hence, the paper develops Thornberry's descriptive model of Entrepreneurial Leadership Strategies into a normative model which suggests four entrepreneurial leadership strategies corresponding with the four levels of Organizational Entrepreneurial Readiness (OER1- 4). In OER1 (unable and unwilling in organizational entrepreneurship), Accelerating leadership strategy is suggested, but in OER2 (unable but willing in organizational entrepreneurship), Mining leadership strategy and in OER3 (able but willing in organizational entrepreneurship) explorer leadership strategy is suggested. Also when organizational entrepreneurial readiness is at the highest level (OER4), integrator leadership strategy is suggested. Moreover, each of the primary strategies of Entrepreneurial Leadership has always a secondary strategy. The secondary strategy of Accelerating and Integrating leadership are Mining and Exploring strategies respectively. Meanwhile, the secondary strategy of Mining leadership is Accelerating or Exploring strategies. Finally at OER3, Mining and Integrating leadership strategies would be the most appropriate backup choices. The integration of Thornberry's model of entrepreneurial leadership strategies with Organizational Entrepreneurial Readiness (Entrepreneurial Orientation) develops it from a descriptive stage to a normative phase leading to a novel situational theory of entrepreneurial leadership.

Keywords: *Entrepreneurial Orientation, Organizational Entrepreneurial Readiness, Accelerating leadership, Mining leadership, Exploring strategy, Integrating strategy*

1. Introduction

Nowadays in the business world, entrepreneurs are considered as agents or catalysts of change, who recognize the opportunity that others can not recognize or consider as a problem. They are, therefore, known as the symbol of diligence and success of business (Kuratko, 2007, p. 2). Unfortunately, entrepreneurs as innovators and creators of corporate vision have faced the problem of developing leadership competency and becoming professional managers to grow their businesses (Fernald,

Solomon, Tarabishy, 2005, p.1). Since the world of business has become very complicated and unpredictable, old approaches or even rather new ones cannot be effective in the long term. In such a condition a thoroughly new leadership strategy is needed to run a business.

This leadership strategy is called entrepreneurial leadership by McGrath & MacMillan (2002). But, in fact, ever since Schulz studied the entrepreneurial leadership concept in his dissertation, there have been few studies in this area such that some researches suffer from a lack of clearly defined measurement tools for evaluating the entrepreneurial leadership variables (Tarabishy, Fernald, & Solomon, 2003, p. 53). In fact, entrepreneurship discipline is a roughly new field of research, and theoretical gaps seem to exist in this field especially with respect to entrepreneurial leadership. Of course, many scholars attempt to bridge these gaps in theory and practice (Stevenson & Jarillo, 1990; Brown, Davidsson, & Wiklund, 2001; Thornberry, 2006) because we need good theories to influence and guide the practices of leaders and scholars. Without a good theory, applied disciplines such as entrepreneurship would be impoverished domains. Theory is constantly evolving, and as our organizations change in response to their external environments, so do the theories on which we build our disciplines need to keep pace (Turnbull, 2002b). Hence, the main purpose of this paper is to answer this question: "What strategies and under what conditions are effective in identifying, assessing, and exploiting the internal advantages of the company and entrepreneurial opportunities?" This question has remained unanswered in the entrepreneurship literature (Kuratko, 2007; Fernald, Solomon, Tarabishy, 2005). This answer is offered in the framework of logic of the entrepreneurial situational leadership theories.

2. Dominant Logic of Situational Leadership Theories

Due to the significance of leadership in the field of management, there have been plenty of studies on it. Preliminary researches considered leadership as intrinsic. Even 50 years of study based on leadership traits could not define a distinctive framework for managers. Hence specialists shifted their focus from intrinsic traits of the leader to his behavior.

In behavioral theories of leadership, researchers would seek the best behavior of the leaders in all conditions, places and times. Hence behavioral theories of leadership were considered normative rather than descriptive. However Fiedler's studies and scientific experiments of other researchers revealed that leadership is situational by nature and there is no best leadership style for all conditions. Agreeing with Fiedler, most leadership theories such as the situational leadership theory of Hersey & Blanchard followed the situational approach. (Kreitner & Kinicki, 2001, p. 471; Hersey, Blanchard, & Johnson, 1996, p. 116). According to Hersey and Blanchard, to use each style is largely dependent on the readiness (ability and willingness) of followers. They break readiness down to four different levels of R1 to R4. As shown in figure 1(a) there are four main leadership styles which match follower's readiness four levels: telling (S1), selling (S2), participating (S3) and delegating (S4). Then, Hersey, Blanchard, and Johnson (1996) extend situational leadership in individual level to team environment (figure 1. b). Logic of selecting team leadership strategies (Defining, Clarifying, Involving and Empowering) is Team Readiness (ability and willingness). Finally, they extend their situational leadership model to Transformational Leadership in organizational level (figure 1. c). Transformational leadership refers to the behaviors of the leaders who stimulate their personnel to identify and fulfill the goals and interests of the organization to reach a higher level of performance (Sarros, Cooper, & Santora, 2008, p. 146).

Figure 1: Hersey, Blanchard and Johnson's Situational, Team and Transformational Leadership Models
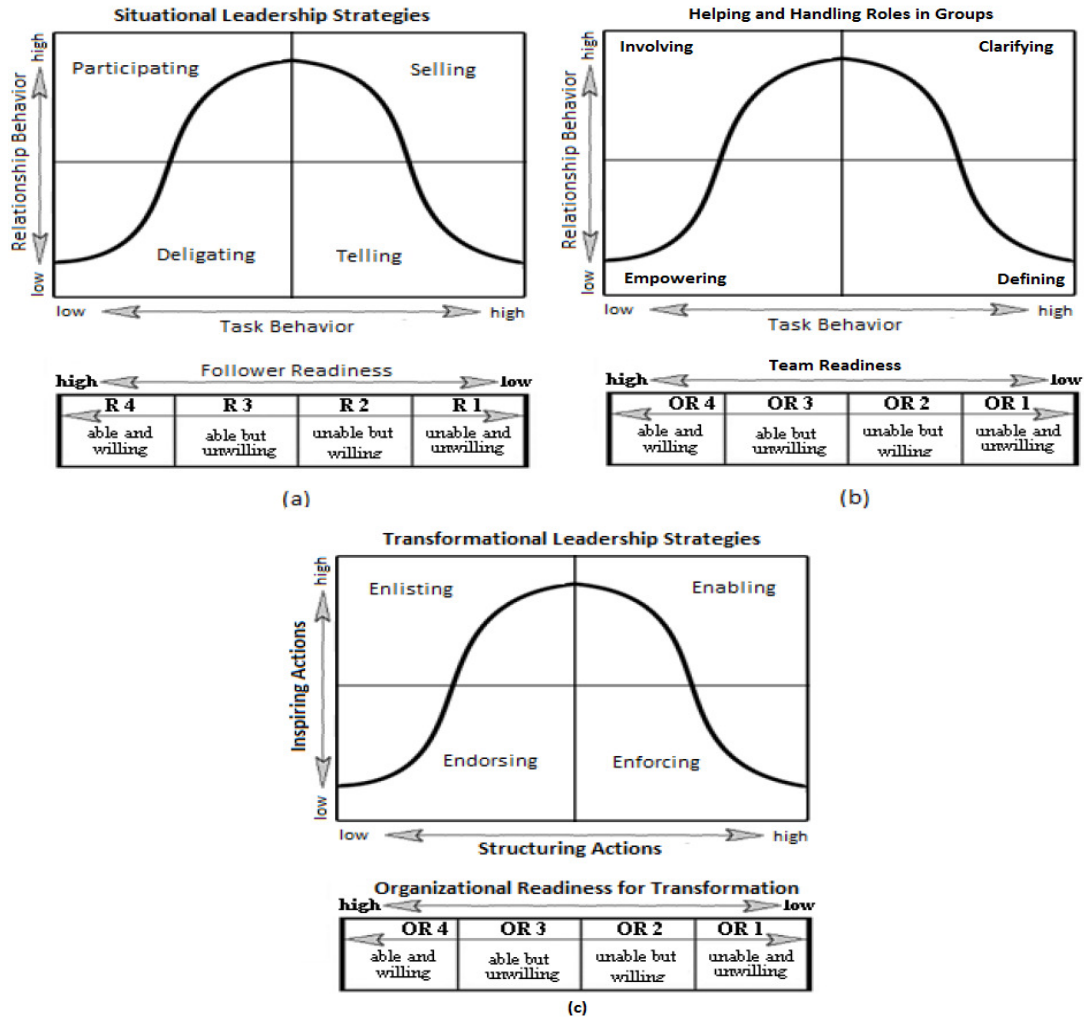
However, reviewing all the studies about transformational leadership, Hersey, Blanchard, and Johnson (1996) divided the transformational leaders' behaviors and actions into two categories: (1) inspiring actions and (2) structuring actions. Combining the continuum of two types of transformational leader's behavior, in the framework of situational leadership theory, four types of strategies are raised: enforcing, enabling, enlisting and endorsing strategies. According to Hersey, Blanchard and Johnson (1996) Organizational Readiness for transformation is the basis for selecting and implementing the transformational leadership strategies.

But along with increasing environmental complexity and dynamism, the leaders of organizations and companies must use a new leadership approach named Entrepreneurial Leadership, which is different from transformational leadership to maintain and sustain their business growth. Transformational leadership is organization-oriented, but in entrepreneurial leadership the focus is on opportunity oriented (Thornberry, 2006, p. 24). However studies on entrepreneurial leadership, particularly those before 2005, had fundamental deficiencies as discussed below.

3. Deficiencies of Entrepreneurial Leadership Studies

Nowadays, entrepreneurial leadership (EL) is considered as a new paradigm of management (Fernald, Solomon, Tarabishy, 2005). But researchers have studied little about entrepreneurial leaders' behavior. Stevenson was among the pioneer scholars who proposed the idea of entrepreneurial management (EM). According to him, EM, as a set of opportunity-based management practices, (Stevenson &

Jarillo, 1990) includes strategic orientation, resource orientation, management structure, reward philosophy, growth orientation and entrepreneurial culture (Brown, Davidsson, & Wiklund, 2001). Late researchers focused more on organizational leadership in order to develop entrepreneurship in business (Choi, 2009; McCarthy, Puffer & Darda, 2010).

Of course as Thornberry (2006) states there have been scant and poor researches about entrepreneurial behaviors of the managers who are helpful to make entrepreneurial organizations and companies. For instance, Pearce, Kramer, and Robins (1997) in a field research identified and analyzed the above-mentioned behaviors and competencies. They identified 11 entrepreneurial behaviors of managers based on factor analysis results. Some of these results include: 1) entrepreneurial leaders do their activities effectively through excluding official bureaucracies; 2) they monitor the good ideas of others; 3) they persuade others to creatively exploit their ideas; 4) they gather the people around them to encounter challenges, and 5) They make an environment that stimulates people to be promoting (Pearce, Kramer, & Robbins, 1997, p. 153).

Table 1: Concept / Key dimensions of Entrepreneurial Leadership

Study	Author, year	Key Concept / dimensions of Entrepreneurial Leadership
1	Pears, karmer & Robbins,1997	Identifying type output through the technique of factor analysis of entrepreneurial management behavior (n=883)
2	Echols & Neck, 1998	Identifying three entrepreneurial behaviors of the leaders: opportunity recognition, catalyzing the opportunity and motivating to exploit the opportunity
3	Floyd & Lane, 2000	In the process of Strategic Renewal, Top, Middle and Operational managers play strategic roles respectively: (Ratifying, Recognizing and Directing) (Championing, Synthesizing, Facilitating and Implementing) (Experimenting, Adjusting and Conforming)
4	Kuratko & Hornsby, 1998	Entrepreneurial leadership includes three elements : Developing the Vision Developing Innovation Developing Venture Teams Structuring for an Entrepreneurial Climate
5	Santora, Seaton & Sarros, 1999	In order to ensure survival, executive directors/CEOs of nonprofit organizations must exhibit entrepreneurial leadership by becoming more vigilant, aggressive, creative, entrepreneurial, and willing to accept and embrace change
6	McGrath and MacMillan, 2000	They defined entrepreneurial leadership as leadership that creates visionary scenarios, motivating and committing a cast of characters for the discovery and exploitation of strategic value creation in an organizational setting. Moreover, entrepreneurial leaders, capable of facilitating proactive transformation, should prove universally effective in mobilizing efforts to redirect the firm, to seek new opportunities, and to nurture growth.
7	Dess, Ireland, Zahra, Floyd, Janney & Lane, 2003	Entrepreneurial leadership is as establishing the conditions conducive to role performance and social exchange. These conditions include organization trust, consensus on dominant logic, and appropriate organizational controls.
8	Gupta, MacMillan, Surie, 2004	entrepreneurial leadership creates visionary scenarios that are used to assemble and mobilize a 'supporting cast' of participants who become committed by the vision to the discovery and exploitation of strategic value creation.
9	Fernald, Solomon & Tarabishy, 2005	Entrepreneurial leaders tend to be individual characteristics or behaviors such as vision, problem solving, decision-making, risk taking, and strategic initiatives.
10	Thurnberry, 2006	Playing active and catalyst roles by leaders Developing a descriptive model for the four strategies of entrepreneurial leadership

The main criticism to this research is that the aforementioned behaviors only reflect the indirect and passive cooperation of entrepreneurial leaders in the process of entrepreneurial leadership. Therefore, as shown in table 1 Echols and Neck 1998 mentioned another aspect of entrepreneurial behavior. In their opinion, there are three types of entrepreneurial behavior: opportunity recognition, opportunity catalyzing and motivation for opportunity exploitation (Echols & Neck,1998, p. 40). These entrepreneurial behaviors are opportunity-based and doing them affirms direct involvement in corporate entrepreneurship activities. Accordingly, in the years after, entrepreneurial leaders' actions were investigated according to the development of the company, and assessing and exploiting the opportunities (Vecchio, 2003).

4. Thurnberry's Descriptive Model of Entrepreneurial Leadership

As table 1 shows, in 2006, Thurnberry stated that the entrepreneurial leader plays active and catalyst roles in the process of corporate entrepreneurship. Also he provides a descriptive model of the four strategies of entrepreneurial leadership (including two dimensions of Entrepreneurial Roles and Entrepreneurial Energy Focus) which will be discussed later.

4.1. Entrepreneurial Roles for Leaders

Corporate Entrepreneurship does not happen without leadership. Leaders and managers at all organizational levels can have key entrepreneurial roles in this process. Understanding these roles, entrepreneurs will be better able to equip their human resources to achieve their vision (Todorovic and Schlosser, 2007). According to Mintzberg (1973) and Adizes (1979), managers should play the entrepreneurial role (along with other managerial roles) by developing new products or services for the organization to reach new markets. It is a reality that the entrepreneurial role could be in different forms which had not been explained before 2000. Floyd and Lane (2000) recognized 10 entrepreneurial roles for managers. Top managers play ratifying, recognizing, and directing roles. Meanwhile, middle managers have championing roles, synthesizing, facilitating and implementing roles. Furthermore, operational managers have experimenting, adjusting, and conforming roles. Examining the role of operational managers, they are sometimes catalysts behind autonomous entrepreneurial initiatives when playing adjusting and conforming roles.

Thornberry (2006) believes that the entrepreneurial leader either plays an active role or acts as the catalyst in entrepreneurial initiatives. Activist entrepreneurial leaders create values and are ready to identify, develop and capture new business opportunities. These opportunities may be identified in their units or cross organizational boundaries or in the business environment. Catalyst leaders do not directly identify and lead the opportunities but build an environment for the organization which features constant innovation and entrepreneurial opportunity recognition. They persuade different people in different ways to identify business development opportunities (Thornberry, 2006, p. 61).

However, one of the most important aspects of entrepreneurial leadership is the role that would be played by managers in corporate entrepreneurship in order to explore entrepreneurial opportunities in the business environment or mine them in the competitive advantages of the organization. But Thornberry (2006) has distinguished another side of the entrepreneurial leadership which will be described in the next section.

4.2. Focus of Entrepreneurial Energy

Another aspect of the actions and behaviors of entrepreneurial leaders is focusing their energy on the inside or outside of the organization. Main sources of corporate entrepreneurship activities are entrepreneurial opportunities or competitive advantages. Recognizing entrepreneurial opportunities that are placed outside the corporate is a key wealth-creation activity and is a common outcome of an entrepreneurial mindset. According to Casson (1982), Shane and Venkataraman (2000), entrepreneurial opportunities are the situations in which new goods, services, raw materials, markets and organizing

methods can be introduced through the formation of new means, ends, or means-end relationships. However, managers are totally concerned with exploiting the quick environmental changes that happen in the industry, market structures, customer needs, technology, and social values to benefit the organization (Kuratko, 2007, P. 28). These behaviors indicate that entrepreneurial energy of the leader is focused on the outside of the organization.

In addition to entrepreneurial opportunities, leaders can identify and even modify corporate competitive advantages in order to create value. Competitive advantages are within the corporate itself. The Resource-Based View (RBV), as one of the substantial theories of strategic management, has overlooked the role of entrepreneurial strategies and entrepreneurial abilities as one of the crucial sources of the competitive advantage of the firm. The RBV suggests that the resources possessed by a firm are the primary determinants of its performance, and these may contribute to a sustainable competitive advantage of the firm. The concept of resources includes all assets, capabilities, organizational processes, firm attributes, information, and knowledge controlled by corporate management that enable the firm to formulate and implement strategies that improve its efficiency and effectiveness (Barney, 1991). Of course, these behaviors indicate that entrepreneurial energy of the leaders is focused on the inside of the corporate.

However, the entrepreneurial leader focuses his energy on the inside of the organization when he or she puts emphasis on its internal factors of the organization to develop the corporate entrepreneurship. But when he or she puts emphasis on external factors of the corporate to develop entrepreneurship, focus of his energy is on the outside of the corporate. According to Thornberry (2006), entrepreneurial leadership strategies have been formed by the two mentioned dimensions which will be described in the next section.

4.3. Entrepreneurial Leadership Strategies

A single continuum cannot explain the behavior of a leader comprehensively (in one direction). Therefore entrepreneurial leaders' actions are practically a combination of the two aspects of their entrepreneurial role (activist or catalyst) and their focus on entrepreneurial energy. As shown in figure 2, some leaders are not directly involved in recognizing and assessing entrepreneurial opportunities but rather only catalyze this process (catalyst role). The leader as catalyst can provide the mechanics of institutional change (Majumdar & Mukand, 2008). On the other hand, these leaders are totally focused on either the inside of the organization or the department under their supervision. Actually these catalyst leaders can be called "accelerators" because they try to increase or accelerate innovation in their units through value-creating or entrepreneurial vision. They try to create the attitudes of "can try it" among their personnel (Thornberry, 2006, p. 8).

Figure 2: Entrepreneurial leadership strategies (Thornberry, 2006, p. 61)
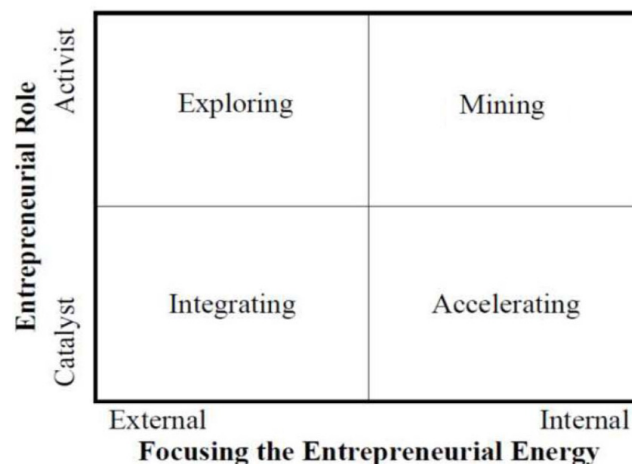
On the other hand, the focus of some managers who are actively involved in corporate entrepreneurship is the inside of the organization. Generally they like a miner, often seek internal advantages (or opportunities within organization), which requires moving beyond the organizational hierarchy. As shown in figure 2, "miner" leaders are interested in restructuring the value chain of the company. This strategy of entrepreneurial leadership can affect many people in the organization who are involved in the value chain and those who are not (Thornberry, 2006, p. 68). Miner leaders find new methods of recognizing and evaluating antique gold in the processes, value chain and actions of the organization (Thornberry, 2006, P.110).

On the other hand, when managers focus their entrepreneurial energy on the outside of the organization and are active in the process of corporate entrepreneurship, they will be the "**explorer**" leaders. These leaders often act in unfamiliar territories which entail risk taking. They either recognize the opportunities outside the organization or take an effective part in recognizing them. These leaders consider customers' complaints as opportunities (Thornberry, 2006, p. 74). Finally, catalyst leaders care about the outside too, since they have a vast scope of responsibilities in the organization. In fact they, as "**integrator**" leaders, consider the organization as a whole and try to make changes in the learning organization. Jack Welch, the CEO of General Electric and Pat McGovern, founder of IDG Company, are integrators in many aspects. In his first years, Jack Welch was worried about how bureaucratic, political, old, and obsolete General Electric was. His tactics for making a "swift and novel" company are mythical these days. McGovern directly divided IDG into smaller and more entrepreneurial units. If one unit grew too big, he divided it into smaller, swifter and much more competitive units (Thornberry, 2006, P.62).

However Thornberry's model (2006) is more comprehensive than other research of entrepreneurial leadership. But since the nature of leadership is context based, Thornberry's model is not situational which will be discussed later.

5. Need a Situational Theory of Entrepreneurial Leadership

Entrepreneurial leadership studies prior to 2000 concentrated on just one role of the leader behavior (only the catalyst role) while even late researchers ignored the dimension of entrepreneurial energy focus. But this model is just a descriptive and is not applicable in practice for managers in order to develop corporate entrepreneurship. In fact, Thornberry's model could not answer the questions below:
   1. Is there any best entrepreneurial leadership strategy?
   2. Which of the entrepreneurial leadership strategies is the most effective in which situation?

The answer to the first question is very simple. Based on situational leadership theories, there is no best strategy; as a result the first question is answered "no". In fact a leader behavior is explained as reciprocally determined by personal, situational and behavioral aspects. The triadic relationship demonstrates that the "situation" is considered not only as a variable determining behavior but also as the "product" of individual perception as well as of active behavior (Winkler, 2010, p.91). As researchers have recognized, leadership styles or approaches cannot be universally applied. It is now recognized that leadership is embedded within organizational contexts .Thus, as Klenke (2008) argued, context determines to a large extent what leaders must and can do, and sets the boundaries within which leaders and followers interact. In other words, the study of leadership is context-dependent (Klenke, 2008). For instance, Jack Welch could not use the same entrepreneurial leadership strategy in General Electric which had used in former firm or companies. Because the entrepreneurial leader cannot have the same entrepreneurial leadership strategy for all places and times, ignoring the organizational and environmental conditions and contexts. Therefore, Entrepreneurial leaders cannot apply Thornberry's Entrepreneurial Leadership Strategies without attention to organizational contexts (Wolcott & Lippitz , 2010). In fact, like Hersey , Blanchard and Johnson's (1996) Situational Leadership Models, Entrepreneurial Leadership Strategies are also situational.

But at this point, the second question-in fact the other inadequacy of entrepreneurial leadership studies-is raised: which entrepreneurial leadership strategy is the most effective in which situation?

The framework developed by Thornberry, 2006, did not practically help the entrepreneurial managers and leaders to answer this question. In other word in Thornberry's descriptive model, there is no a basis for selecting entrepreneurial leadership strategies. Since Entrepreneurial Orientation (EO) is the most important entrepreneurial context in organizational level, it is suggested as a basis for selecting entrepreneurial leadership strategies. A search of the ABI/INFORM database using the phrase "Entrepreneurial Orientation" reveals that by the end of 2010, the concept of EO had been referenced in 256 scholarly journal articles. One hundred and nine of these 256 articles were published between January 2008 and December 2010. That is, within the field of entrepreneurship, there is now greater attention paid to the topic of EO than to corporate entrepreneurship, although many scholars consider EO to be an aspect of corporate entrepreneurship. Second, research on the topic of EO is growing at an increasing rate (Covin and Lumpkin,2011). Therefore it should be investigated relationship between Entrepreneurial Orientation, and the actions, behaviors, or strategies of entrepreneurial leaders. In fact in order to answer the second question, the Narrative Review is used as research method which will be described in the next section.

6. Research Method

Entrepreneurship knowledge is among the new sciences and is in its primary stages; hence entrepreneurship research for theory building (Rauch & Frese, 2009, p. 29) needs to be creatively repeated. Theory building is the basis of scientific development in all fields and, in particular, new scientific areas like entrepreneurship (Reio, 2010, p. 224). The objective of this paper is theory building on entrepreneurship leadership by using narrative review. Narrative review, as a theory building method, has been used in much of leadership research. Bryman (2004) showed that qualitative research has made at least some important contributions to certain areas of leadership.

In other hand, the foundation of theorization consists of "selection", "explanation", "combination", and "idea generation" (Zahra, 2007, p 451). In fact, one way to develop theories is to creatively combine different theoretical approaches (Zahra, 2007, p 451; Coppedge, 2002, p. 1). Of course theory building by combining theoretical lenses faces delicate challenges. Editors of Academy of Management Review have organized their thinking on two dimensions describing the relationship between the combined lenses:(1) the proximity of their addressed phenomena and (2) the congruence of their underlying assumptions (Editors' Comments, 2011). Further another important challenge in theoretical studies is the discovery of **relevant and strong logic to explain and make the theory re-accessible to researchers** (Lynham, 2002, p 2). As narrative review is the synthesis of the findings of multiple studies aimed at answering specific questions of concern, this paper uses narrative review to investigate the possibility of combining "Entrepreneurial Orientation Theory" and "Entrepreneurial Leadership Strategies Model" (Lowe and Gradner, 2000; Rauch and Frese, 2009, p. 29).

To achieve this goal, the current paper tries to answer the question of "**which entrepreneurial strategy is the most effective in which situation?"** In reply to answer this question, in the narrative review of literature, the paper builds up on the answer to the following questions:

- *Is there any proximity between Entrepreneurial Leadership Strategies and Entrepreneurial Orientation?*
- *Is there any congruency between assumptions of Entrepreneurial Leadership Strategies and Entrepreneurial Orientation?*

In order to answer these questions, as diagram 3 shows, keywords were searched through scopus search tool on publishers such as Elsevier; Springer; Wiley-Blackwell. Adding other non-systematically found works resulted in 24 papers that were used in this study.

Figure 3: Flow-diagram of the study's narrative review
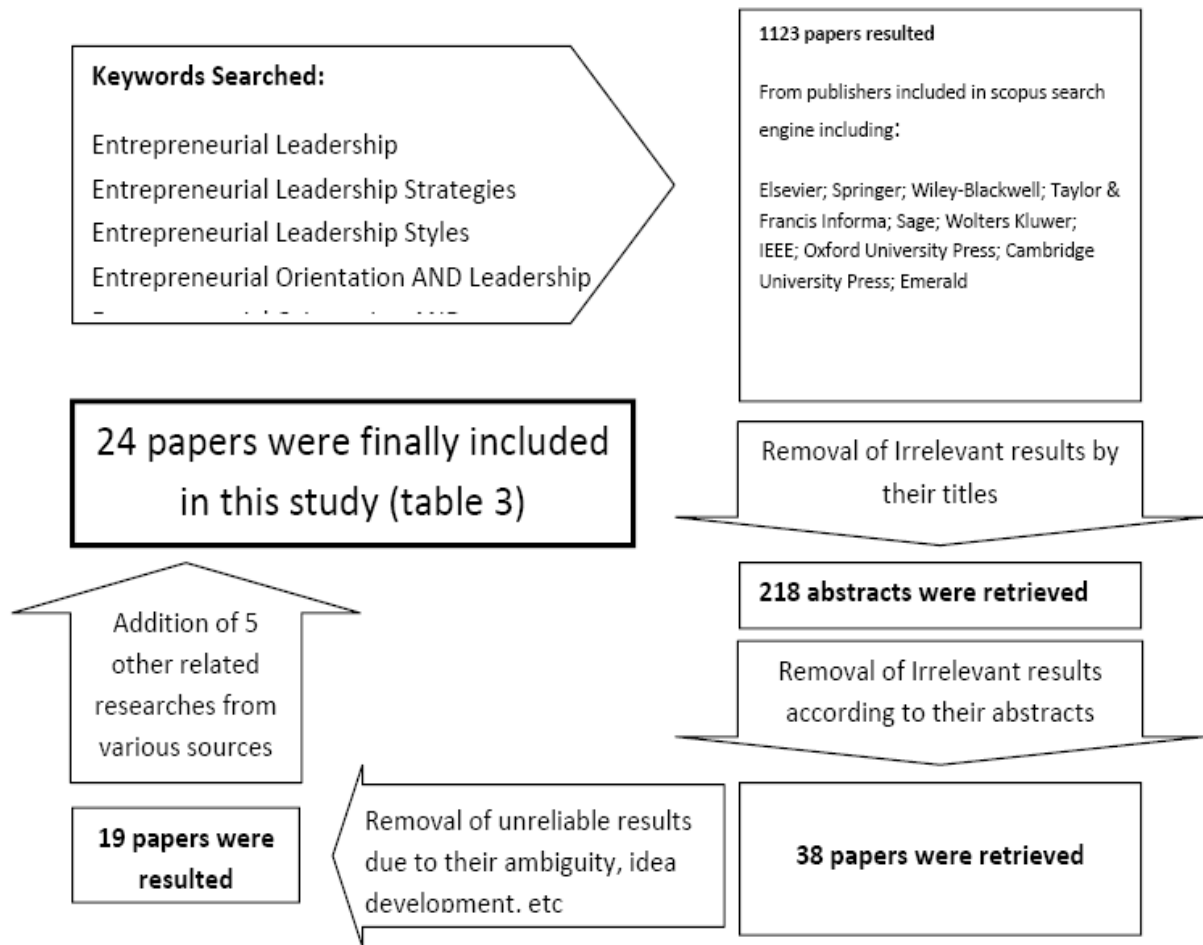
Results of this review will be presented in the next section confirming the existence of proximity of dimensions, and congruence of assumptions between the combined theories in this paper.

7. Results

As table 2, Stevenson & Jarillo, (1990) found a critical relationship between entrepreneurial behavior and attitude and the ability of firm individuals to exploit opportunities using a narrative review method. Kuratko & Hornsby (1999) used a narrative review approach to conclude that corporate entrepreneurship climate along with organizational characteristics (such as risk-taking propensity) lead to corporate entrepreneurial activities. Brown, Davidsson, & Wiklund (2001) investigated the correlation between entrepreneurial management and entrepreneurial orientation and concluded that five from six dimensions of Stevenson's entrepreneurial management model (strategic orientation, management structure, reward philosophy, growth orientation and entrepreneurial culture) are related to entrepreneurial orientation (innovativeness, proactiveness and risk-taking). Tarabishy (2006) found positive correlation between creative leadership and entrepreneurial orientation. Chen (2007) used a regression analysis method and concluded that new venture's innovative capability can be improved by the joint contribution of higher entrepreneurial leadership and more creativity in entrepreneurial teams. His findings also imply that the contingent impact of creativity in teams on the leadership–innovation relationship needs to be considered. De Jong & Wennekers, (2008) used a narrative review technique and synthesized that intrapreneurs' behavior is influenced by their organization and its people. They suggest that intrapreneurial behavior is positively related to individuals' and organization's performance. Also Politis and Politis (2009), investigated the relationship between leader behaviors

(opportunity thinking, obstacle thinking) and EO (innovation, risk-taking, proactiveness) using a SEM technique. Their findings support that both people-oriented and task oriented leadership styles are important constructs in predicting firms' entrepreneurial orientation. Moreover, it was found that opportunity as opposed to obstacle-type thought patterns could positively and significantly affect forward-looking perspective and entrepreneurial orientation.

Table 2: Result of Narrative Review on research of Entrepreneurial Leadership and Entrepreneurial Orientation

	Author, year	Variables and relationships between them			Research method	Research Key findings
		Variable 1	**Variable 2**	**Variable 3**		
1	Stevenson & Jarillo, 1990	firm entrepreneurial behavior firm success rate	attitude of firm individuals ability of firm individuals to exploit opportunities		Narrative review	The level of entrepreneurship within the firm (i.e. the pursuit of opportunities) is critically dependent on the attitude of individuals within the firm, to put individuals in a position to detect opportunities, employees' (subjective) ability to exploit opportunities.
2	Kuratko & Hornsby,1998	Corporate Entrepreneurship Climate: Management Support, Work Discretion, Reward Reinforcement, Time Availability, Organizational boundaries	corporate entrepreneurial activities		Narrative review	The Corporate Entrepreneurship Climate(Organizational Characteristics) along with Organizational Characteristics(such as risk taking propensity) lead to corporate entrepreneurial activities
3	Brown, Davidsson, & Wiklund, 2001	Entrepreneurial Management	Entrepreneurial Orientation		Correlation	five from six dimensions of Stevenson's Entrepreneurial Management Model (Strategic Orientation, Management Structure, Reward Philosophy, Growth Orientation and Entrepreneurial Culture) have relations to Entrepreneurial Orientation(Innovativeness, Proactiveness and Risk taking) just Resource Orientation has not related to Entrepreneurial Orientation
4	Jung et al.,2003 (Adapted from Chen, 2007)	Transformational leadership	Organizational Innovation		Correlation	Jung et al. (2003) found a direct and positive link between transformational leadership and organizational innovation assessed by patents and R&D intensity.
5	Ireland, Hitt & Sirmon,2003	Entrepreneurial leadership	Strategic Management Of Resources	Applying Creativity Developing Innovations	Narrative review	entrepreneurial leadership, through the strategic management of resources leads to apply creativity and to develop innovations in firm.

Table 2:   Result of Narrative Review on research of Entrepreneurial Leadership and Entrepreneurial Orientation - continued

6	Tarabishy ,2006	Creative leadership	EO-Innovativeness EO-risk Taking EO-Proactiveness		Correlation	the positive relationship between Creative leadership and Entrepreneurial Orientation
7	Ensley , Pearce & Hmieleski, 2006	Transactional Leadership Transformational Leadership	Environmental Dynamism	New Venture Performance	Correlation	influence of entrepreneur leadership behavior on new venture performance is likely to be moderated by the level of environmental dynamism.
8	Todorovic, & Schlosser, 2007	Charismatic Leadership Machiavellianism Leadership	Entrepreneurial Orientation (Eo)	Organizational Performance	Correlation	The Proposed Framework suggests that a charismatic leadership style (with resulting organizational citizenship behavior by the followers) will amplify the EO-Performance relationship, while the Machiavellian leadership style (with corresponding follower behavior) will reduce the EO-Performance relationship.
9	Soriano & Martı´nez, 2007	relationship-oriented leadership style task-oriented leadership style participative leadership style	the entrepreneurial spirit		Regression analysis	relationship-oriented leadership style will positively enhance the chances of transmitting the entrepreneurial spirit A task-oriented leadership style will reduce the chances of transmitting the entrepreneurial spirit to the work team. A participative leadership style will positively enhance the chances of transmitting the entrepreneurial spirit to the work team.
10	Chen, 2007	Entrepreneurial Leadership	Creativity in Entrepreneurial teams	New Venture's Innovative Capability (Patent creation)	Regression Analysis	new venture's innovative capability can be improved by the joint contribution of higher entrepreneurial leadership and more creativity in entrepreneurial teams. The findings also imply that the contingent impact of creativity in teams on the leadership–innovation relationship needs to be considered.
11	Darling & Beebe , 2007	entrepreneurial leadership strategies	levels of excellence		Narrative Review	The keys to achieving acceptable levels of excellence involve four key entrepreneurial leadership strategies: attention through vision, meaning through communication, trust through positioning and confidence through respect.

Table 2: Result of Narrative Review on research of Entrepreneurial Leadership and Entrepreneurial Orientation - continued

12	Soriano & Martı´nez,2007	leadership based on relationships task-oriented leadership participative leadership	entrepreneurial spirit		Structural Equation Modeling	leadership based on relationships shows a positive impact, with an intensity of more than double that of participative leadership. A task-oriented leadership style reduces the chances of transmitting the entrepreneurial spirit to the work team by having a negative influence on the generation of collective entrepreneurship in the firm.
13	Ling,simsek Lubatkin,Lyon, &veiga,2008	Transformational Leadership Risk propensity	Corporate Entrepreneurship			Transformational CEOs influence TMTs' behavioral integration, risk propensity, decentralization of responsibilities, and long-term compensation and that these TMT characteristics impact corporate entrepreneurship.
14	Scheepers, Hough & Bloom,2008	The Internal factors: managerial support work discretion Rewards/reinforcement	CE capability (EO) EO-Innovativeness EO-Proactiveness EO-Risk taking		Structural Equation Modeling	The Internal factors (CE Climate) is positively related to CE capability(Innovativeness, Proactiveness and Risk-taking)
15	Elenkov, Judge & Right,2008	product-market innovation administrative innovation	Strategic(transformational) leadership behaviors			Strategic(transformational) leadership behaviors were found to have a strong positive relationship with executive influence on both product-market and administrative innovations.
16	Chung-Wen Yang, 2008	Transformational leadership Transactional leadership Passive-avoidant leadership	Entrepreneurial Orientation	Business Performance	Regression Analysis	leadership style affect the development and implementation of entrepreneurial orientation in small and medium enterprises in Taiwan transformational leadership is significantly. Transformational leadership with higher entrepreneurial orientation can contribute to higher business performance.
17	De Jong & Wennekers,2008	Firm-level antecedents: Intrapreneurial climate Management support Resource availability	Intrapreneurial behavior	Intrapreneurial Consequences: Individual's performance Innovative output	Narrative Review Synthesis	Intrapreneurs behavior are influenced by their organization and its people intrapreneurial behavior is positively related to individuals' and organization's performance.

Table 2: Result of Narrative Review on research of Entrepreneurial Leadership and Entrepreneurial Orientation - continued

18	Fis & Cetindamar,2009	Managerial Support	Entrepreneurial Orientation		Path Analysis	EO has positively related to management support mechanisms
19	Gumusluoglu, & Ilsev,2009	Transformational Leadership	External Support for Innovation Internal Support for Innovation	Organizational Innovation	Hierarchical Regression Analysis	Transformational leadership has positively association with organizational innovation. Specifically, the relationship between transformational leadership and organizational innovation was stronger when external support was at high levels than when there was no external support.
20	Choi,2009	Entrepreneurial Management	Aggressive Practice		Narrative Review	Watanabe's thorough analysis of Bombay's competitive advantages explained that the aggressive practice of entrepreneurial management was the industrial essence that explains the timely Japanese development in the period of visible hands as well as mass production.
21	Hornsby, Kuratko, Shepherd & Bott,2009	Managerial support Work discretion	Entrepreneurial Action		Regression Analysis	the positive relationship between managerial support and entrepreneurial action the positive relationship between work discretion and entrepreneurial action The findings suggest that managerial level provides a structural ability to "make more of" organizational factors that support entrepreneurial action
22	Politis and Politis,2009	Leader 'behaviors: Opportunity Thinking Obstacle Thinking	EO-Innovation/ Risk Taking EO-Proactiveness		Structural Equation Modeling	The findings support that both people-oriented and task oriented leadership styles are important constructs in predicting firms' entrepreneurial orientation. Moreover, it was found that opportunity as opposed to obstacle-type thought patterns could positively and significantly affect Forward-looking perspective and entrepreneurial orientation.

Table 2: Result of Narrative Review on research of Entrepreneurial Leadership and Entrepreneurial Orientation - continued

23	Hornsby,Kuratko, Shepherd & Bott, 2009	Corporate Entrepreneurship Climate: managerial support work discretion Rewards/reinforcement Time availability	Management level	New ideas implemented	Regression Analyses	the relationship between managerial support, work discretion with New ideas implemented is more positive for senior and middle level managers than it is for lower-(first) level managers, managerial level provides a structural ability to "make more of" organizational factors that support entrepreneurial action.
24	Bouchard & Basso ,2011	Intrapreneurship	Entrepreneurial Orientation		Narrative Review	summarizes various findings regarding the antecedents of EO and intrapreneurship in SMEs and elaborates a series of testable propositions linking EO to intrapreneurship.

As shown in table 2 in Fernald, Solomon, and Tarabishy's (2005) study, there is a positive relationship between creative leadership and entrepreneurial orientation. Also according to table 2, John and Denis Politis (2009) found that opportunity as opposed to obstacle-type thinking patterns could positively and significantly affect forward-looking perspective and entrepreneurial orientation. Horsnby et al.(2009), using a sample of 458 managers moderated by Poisson regression analysis, found that the relationship between managers' perceptions of the organizational environment and the number of entrepreneurial ideas implemented varied across managers of different structural levels. Specifically, (1) the positive relationship between managerial support and entrepreneurial action is more positive for senior and middle level managers than it is for lower-level (first) managers, and (2) the positive relationship between work discretion and entrepreneurial action is more positive for senior and middle level managers than it is for first-level managers. These findings suggest that managerial level provides a structural ability to "make more of" organizational factors that support entrepreneurial action.

In general, as table 2 shows, in most of the reviewed studies, the relationship between entrepreneurial leadership and entrepreneurial orientation can be distinguished. It reflects the close proximity between the two theoretical lenses. In other words, as table 3 shows EO could be understood as a general attribute or lasting direction of thought, inclination or interest pertaining to new entry (Covin and Lumpkin, 2011; Lumpkin and Dess,1996). In fact, the nature of EO lens is dispositional and behavioral.

On the other hand, the nature of Entrepreneurial Leadership lens depicts a managerial orientation a long with the focus of entrepreneurial Energy on internal and external dimensions of the firm. Therefore those theoretical lenses have similar basic natures. Also level of analysis in both lenses of Entrepreneurial Orientation and Entrepreneurial Leadership Strategies is at firm level. Finally, according to table 3, EO is an organizational attribute and behavioral pattern, ranging from low to high, to new entry (new business opportunities). Therefore, the basic assumptions of those two theoretical lenses are compatible.

Table 3: Basic nature, Level analysis and Basic Assumptions of Entrepreneurial Orientation and Entrepreneurial Leadership Strategies

Lenses criteria	Entrepreneurial Orientation Theory	Entrepreneurial Leadership Strategies Model
Basic nature	EO is considered as an organizational **attribute** and sustained entrepreneurial **behavioral pattern** (Covin and Lumpkin, 2011; Wales, Monsen &Mckelvie, 2011, p. 897; Lumpkin and Dess, 1996).	Entrepreneurial Leadership states leader's activist - catalyst **orientation** a long with focusing on entrepreneurial Energy on the internal and external dimensions of the firm (Thornberry, 2006, p. 14).
Level of analysis	firm-level	firm-level
Basic Assumptions	EO is an organizational attribute and behavioral pattern (ranging from low to high) across five dimensions; innovativeness, risk taking, Autonomy, proactiveness, competitive aggressiveness (Covin and Lumpkin, 2011) to **new entry (new business opportunities)**	Entrepreneurial Leadership is inherently **opportunity-focused** (Thornberry, 2006, p.14).

However, proximity and the congruence of assumptions of Entrepreneurial Orientation Theory and Entrepreneurial Leadership Strategies can provide a good basis for combining them and developing Thornberry's entrepreneurial leadership model which will be discussed later.

8.   Integrating Entrepreneurial Leadership Strategies with Entrepreneurial Orientation

Theory building generally consists of two phases: the descriptive phase and the normative (prescriptive) phase. The descriptive phase is the preliminary phase because the researchers should first pass this phase in order to develop the normative (prescriptive) phase (Carlile and Christensen, 2004, p. 5). Gupta, MacMillan & Surie (2004) believe that the concept of entrepreneurial leadership involves fusing the concepts of: entrepreneurship, entrepreneurial orientation, entrepreneurial management and leadership. In fact, they state for the first time implicitly that entrepreneurial leadership is connected with entrepreneurial orientation.

Moreover as figure 1 shows in situational leadership theory, the basis for the selection of a leadership style is subordinate's readiness as in team and transformational situational leadership models, choosing a leadership strategy is function of team readiness and organizational readiness for transformation. This can happen when there is no basis for the selection of entrepreneurial leadership strategies in Thornberry's theory. Meanwhile research results of Ardichvili, and Cardozo (1998) show that the majority, more than 56 percent, of Russian entrepreneurs have claimed to be **"situational" leaders**, defined as both autocratic and democratic, switching from one style to another depending on the situation (Ardichvili & Cardozo, 1998) which can also be known as a situational approach for Entrepreneurial Leadership Strategies.

Considering the results of the narrative review on entrepreneurial leadership research, there is a relationship between the behavior of the entrepreneurial leader and entrepreneurial orientation of the organization (e.g. Politis & Politis, 2009; Hornsby, Kuratko, Shepherd & Bott, 2009; Choi, 2009; Bouchard & Basso, 2011). Therefore, Entrepreneurial Orientation can be synthesized with Thornberry's Entrepreneurial Leadership Strategies. In this paper the "Entrepreneurial Orientation" concept is considered as Organizational Entrepreneurship Readiness (OER) to develop the descriptive model of Thornberry's entrepreneurial leadership strategies to the normative (prescriptive) phase. Entrepreneurial orientation has been investigated in more than 100 studies spanning dozens of nations (Hansen, et al. 2011, p. 62). In fact, "entrepreneurial orientation" as organizational context (situation) has been a very important key element in corporate entrepreneurship and even strategic management for two decades (Rauch, Wiklund, Lumpkin, & Frese, 2009, p. 1). It would direct the entrepreneurial leaders' behaviors. As contingency leadership theories such as the situational leadership theory have

revealed, the influence of organizational contexts on leadership effectiveness is a fundamental though scarcely studied subject. Ripoll, Rodriguez, Barrasa, and Mirko (2010) believe that organizational contexts have an influence on leadership, and some of their characteristics may facilitate or inhibit the leaders' behaviors. They found that in 'weak' (entrepreneurial) contexts, the leaders' motives would be more salient than in 'strong' (non-entrepreneurial) contexts (Ripoll, et al., 2010).

Miller (1983) proposed that the EO of an organization is based on how much it innovates, acts proactively, and is willing to take risks and the construct's further development by Covin and Slevin (1990) has established what has become a commonly accepted conceptualization of what it means for a firm to be "entrepreneurial." Although the concept of entrepreneurship as new entry is itself a topic brimming, but Lumpkin and Dess (1996) chiefly concerned with Entrepreneurial Orientation (EO). They state (*Lumpkin and Dess, 1996, p. 137):*

"EO refers to the processes, practices, and decision-making activities that lead to new entry. It emerges from a strategic-choice perspective, which asserts that new-entry opportunities can be successfully undertaken by "purposeful enactment". Thus, it involves the intentions and actions of key players functioning in a dynamic generative process aimed at new-venture creation. The key dimensions that characterize an EO include a propensity to act autonomously, a willingness to innovate and take risks, and a tendency to be aggressive toward competitors and proactive relative to marketplace opportunities"

In fact, Lumpkin and Dess (1996) developed EO construct to the key dimensions: Innovativeness, Proactiveness, Risk taking, Autonomy and Competitive aggressiveness. The extent to which each of these dimensions is useful for predicting the nature and success of a new undertaking may be contingent. In this paper, according to Lumpkin and Dess (1996) it is assumed that the five dimensions of EO may vary independently, depending on the environmental and organizational contexts.

Table 4: Entrepreneurial Willingness and Ability in Entrepreneurial Orientation

EO dimensions	Focus	
	Entrepreneurial Willingness	**Entrepreneurial Ability**
Innovativeness	Innovativeness reflects a firm's basic **willingness** to engage in and support new ideas, novelty, experimentation, and creative processes.	**Effort** to synthesize disparate efforts across functional lines and flexibility in adapting new processes.
Proactiveness	Covin & Slevin(1989) and (Miller, 1983) state proactiveness is the firm's **tendency** to lead rather than follow in the development of new procedures and technologies and the introduction of new products or services.	The term Proactiveness is defined in Webster's Ninth New Collegiate Dictionary (1991: 937) as "**acting** in anticipation of future problems, needs, or changes."
Risk taking	The degree to which a firm is **willing** to make large and risky resource commitments-i.e., those which have a reasonable chance of costly failures" Baird and Thomas identified three types of strategic risk: (a) "venturing into the unknown," (b) "committing a relatively large portion of assets," and (c) "borrowing heavily"	Other factors may also be important to predicting risk taking, such as how the risk problem is framed (Kahneman & Tversky, 1979), results of past risk taking and the **ability** to perform under risky conditions.
Autonomy	Autonomy means the **will t**o be self-directed in the pursuit of opportunities.	Autonomy means the **ability t**o be self-directed in the pursuit of opportunities. In an organizational context, autonomy refers to action taken free of stifling organizational constraints
Competitive aggressiveness	It refers to a firm's **propensity** to directly and intensely challenge its competitors to achieve entry or improve position, that is, to outperform industry rivals in the marketplace.	According to Porter (1985) Competitive aggressiveness is "**doing** things differently," that is, reconfiguration; **changing** the context, that is, redefining the product or service and its market channels or scope; and **outspending** the industry leader.

According to table 3, the five EO dimensions are included a firm's Entrepreneurial willingness and abilities to new Entry:

- **Entrepreneurial Ability**

This dimension consists of entrepreneurial events (activity) such as delivering new products/services, organizational strategic renewal, risk taking behaviors, ambiguity tolerance, lots of interactions with the external environment, gathering active customers' information, etc. (Kuratko, et al. 2007; Hersey et al. 1996, p 528). Besides, entrepreneurial abilities include knowledge, experience and the skill to start a business and deliver a new product or service by the organization (Bosma et al., 2007, p.11).

- **Entrepreneurial Willingness**

On the other hand, there is entrepreneurial willingness which consists of components such as innovativeness, proactiveness, risk taking, autonomy, aggressive competition, attitude toward recognition of opportunities for creativity in the organization, freedom of thought, and individualism (Hersey et al. 1996, p. 529; Dess and Lumpkin, 1996; Kuratko, et al., 2003).

Like organizational readiness for transformation, organizational readiness for entrepreneurship can also be illustrated in two continuums. For instance, in the broadest sense, innovativeness may occur along a continuum from a simple willingness to either try a new product line or experiment with a new advertising venue, to a passionate commitment to master the latest in new products or technological advances (Lumpkin and Desss, 1996). Thererfore, Organizational Entrepreneurship Readiness (OER) varies according to the Organization's Entrepreneurial Abilities and Willingness. Not all of the organizations or even their different departments have both of the dimensions of Entrepreneurial Orientation. Hence Entrepreneurial Orientation (Organizational Entrepreneurship Readiness) can be classified into certain levels. As shown in Figure 5, companies may or may not have entrepreneurial willingness. In addition, entrepreneurial ability and inability are two extremes of the continuum. In fact the four levels of Organizational Entrepreneurship Readiness reflect the degree of Entrepreneurial Orientation in a firm (Engelen,2010).

In the author's view, as Followers' Readiness for work is a function of their abilities and willingness for doing work and as Team Readiness is determined by team abilities and willingness and finally Organizational Readiness for transformation is determined by organizational culture, Organizational Entrepreneurship Readiness (OER) is also a function of Entrepreneurial Orientation. Hence understanding the strengths and weaknesses of the company in entrepreneurial orientation is a good starting point for leading the development of entrepreneurship in the organization (Thornberry, 2006, p. 223). When the organization has neither entrepreneurial abilities nor entrepreneurial willingness, it is in OER1 (the lowest readiness level). But an organization that has abilities of recognizing entrepreneurial opportunities is in OER4 (the highest organizational entrepreneurship readiness).

Figure 4: Mapping EO onto Organizational Entrepreneurship Readiness Levels
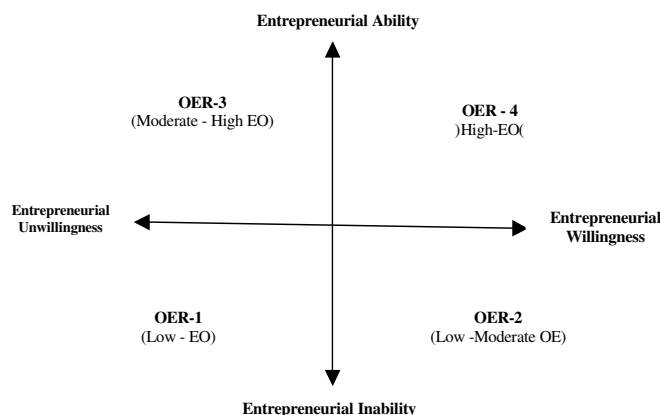
Since according to Narrative Review results, there is relationship between Entrepreneurial Orientation and entrepreneurial leadership actions or behaviors, therefore Thornberry's entrepreneurial leadership strategies can be mapped onto Organizational Entrepreneurship Readiness. In fact, the logic of Hersey, Blanchard and Johnson's Situational Leadership Theories can be used to propose a new entrepreneurial situational leadership theory to fill the theoretical gap in Thornberry's Model. For instance, in the Hersey, et al. (1996) matches the four transformational leadership strategies to four levels of organizational readiness for transformation. Based on this logic, Thornberry's four entrepreneurial leadership strategies can be matched with the four levels of Organizational Entrepreneurship Readiness (OER).

Combining Organizational Entrepreneurial Readiness and Thornberry's Entrepreneurial Leadership Strategies, a new theory entitled "Entrepreneurial Situational Leadership Theory" with certain assumptions is developed(figure 5). **The first** assumption of this theory is that leaders adapt their entrepreneurial leadership strategies to their Organization's Readiness for Entrepreneurship, based on how able and willing the organization is to enter entrepreneurial activities. **The second** assumption of this theory is that Organization's Readiness for Entrepreneurship is a function of four combinations of high/low entrepreneurial ability and willingness of the organization just as. **The third** assumption of this theory presumes that entrepreneurial leadership strategies reflect the role of the entrepreneurial leader (active/catalyst) and the focus of their entrepreneurial energy relative to the organization and its environment.

According to Entrepreneurial Situational Leadership (ESL) theory considers Entrepreneurial Orientation as the basis for selecting entrepreneurial leadership strategies in the organization. In fact, entrepreneurial orientation as organizational entrepreneurship readiness (OER) is the central construct in the studies of corporate entrepreneurship. Based on the above mentioned logic and assumptions, four propositions are made herein. In other words the appropriate entrepreneurial leadership strategies for each level of Organizational Entrepreneurship Readiness are as follow:

Figure 5: Entrepreneurial Situational leadership Theory

Proposition 1: When Organizational Entrepreneurship Readiness (EOR) is at its lowest level Accelerating Strategy (S1) is the most effective leadership strategy to create and develop Corporate Entrepreneurship [OER1/S1].

In an organization where Organizational Entrepreneurial Readiness is at its lowest level, staff have no or little the willingness and abilities to recognize and evaluate new business opportunities and

cannot exploit business's internal advantages. Therefore, the entrepreneurial leader should provide with the organizational and individual contexts to accelerate the development of entrepreneurship in the organization. In accelerator strategy, the entrepreneurial leader accelerates or improves innovation in the unit under his supervision through developing entrepreneurial vision. In this level of readiness, the entrepreneurial leader tries to pleasantly depict the future of entrepreneurship development in the organization and persuade others to adopt it, but he does not directly involve in entrepreneurial activities. Of course, there are some researches that agree with this proposition. For example, John Politis and Denis Politis (2001) state that there is correlation between initiating structure and innovation and risk taking (r=0.24). In accelerating strategy, the entrepreneurial leader focuses his energy on removing structure barriers and improving business processes to increase innovation.

Managers play a key role in encouraging employees to believe that innovation is expected of all members of the organization. Managerial supports indicate the willingness of managers to facilitate and promote entrepreneurial activity in the firm (Stevenson and Jarillo, 1990; Kuratko et al., 1999; Pearce et al., 1997). Those supports can take many forms, including championing innovative ideas, providing necessary resources or expertise, or institutionalizing the entrepreneurial activity within the firm's system and processes (Hornsby et al., 2002). According to Scheepers, Hough & Bloom (2008) management support for CE is positively related to entrepreneurial orientation (innovativeness, proactiveness and risk-taking). Hornsby, Kuratko, Shepherd, and Bott (2009) using a sample 458 managers found that there is the positive relationship between managerial support and entrepreneurial actions in organization.

However, behaviors of Accelerator Leaders such as encouraging personnel to develop new ideas, not punishing for the mistakes in the learning process ,create entrepreneurial interests and values in their employees. Further, the Accelerator Leader replaces people who do not have the potential to develop entrepreneurial skills, experiences, ideas and values with individuals who are more suited to the entrepreneurial activities, inside and outside the business. Moreover, the Accelerator Leader asserts entrepreneurial visions (Kuratko, 2010) by defining the critical success factors and modeling the belief systems, Values and actions (Hersey, Blanchard & Johnson, 1996) of the Entrepreneurial Corporate.

However, developing entrepreneurial visions and values makes the staff more interested in corporate entrepreneurship while they lack entrepreneurial abilities (OER2). Therefore, the second proposition is raised:

Proposition 2: When Organizational Entrepreneurship Readiness is at its second level (entrepreneurial willingness and inability) Mining Strategy (S2) is the most effective entrepreneurial strategy to develop corporate entrepreneurship [OER2/S2].

According to the Resource-Based View (RBV), competitive advantages are a function of the resources the firm develops or acquires to implement its product market strategy (Irland, Hitt & Sirmon, 2003). An competitive advantage that a company has over its competitors, allows it to generate greater value than other company in competition. From a leadership perspective, corporate entrepreneurship based on resource-based view (RBV) reflects the Mining Strategy.

In an organization where Organizational Entrepreneurial Readiness is at its second level (OER2), staff have the willingness to enter new business activities while there is no ability to recognize and evaluate new business opportunities, and exploiting organizational internal advantages is not possible. Therefore, the miner entrepreneurial leader should actively and directly (activist role) focus his entrepreneurial energy on recognition and exploitation of internal advantages. This kind of entrepreneurial leader acquires the physical resources such as money and materials that will be required for the corporate entrepreneurial activities. In Mining Strategy, entrepreneurial leader evaluates the supply chain of the company and identifies the issues that can create new value chains in the processes of the firm and filly reconfigures the business assets intended to make new values for customers (Thornberry, 2006).

Innovation is the key to developing and successfully exploiting competitive advantages. Innovation and organizational learning combination bring new products, new internal processes, and develop new business models and expand new markets to the company. But the challenge of the miner

leader is to develop innovation as a core competency of the business. The company's strategy for entrepreneurship serves to stimulate such innovation. Company leaders are able to exploit the advantages they own today, while simultaneously use innovation to shape the advantages they intend to own today and use tomorrow, and to increase the probability of long-term survival, growth and financial success (Kuratko, Morris & Covin, 2010).

Anyway as Organizational Entrepreneurship Readiness further increases throughout time, entrepreneurial ability of the staff improves while they lose their willingness and motivation to engage in entrepreneurial activities (OER3). Therefore the third proposition is raised.

Proposition 3: When Organizational Entrepreneurship Readiness is at its third level (entrepreneurial ability and unwillingness*) Exploring Strategy (S3) is the most effective entrepreneurial strategy (external energy focus and activist role of the leader) to develop corporate entrepreneurship [OER3/S3].*

It is reality that yesterday's competitive advantages can be today's disadvantages. For instance, Black and Decker's consolidation into a few global-scale facilities in the 1980s proved a disadvantage in the 1990s. Organizational practice, core competencies, and business models confer competitive advantages because factors present under particular conditions over a particular period of time (Kuratko, Morris & Covin, 2010, p.168). Therefore, leaders must study their business environment in order to explore opportunities. Of course Entrepreneurial opportunities are situations in which new goods, services, raw materials, markets and organizing methods can be introduced through the formation of new means, ends, or means-ends relationships. Entrepreneurial opportunities are in the external environment of the corporate (Eckhardt & Shane,2003). In fact recognizing and exploiting entrepreneurial opportunities is a kind of management approach. Stevenson, et al. (1990) define entrepreneurship as an opportunity-based firm behavior and emphasizes entrepreneurial management in the corporate. He conceptualizes entrepreneurship as a management approach that has at its heart an all-consuming passion for the pursuit and exploitation of opportunity without regard to resources currently controlled. Stevenson contrasts entrepreneurial behavior with administrative behavior. Along the spectrum of behaviors between these extremes, promoter firms are placed at the entrepreneurial end and trustees at the administrative end (Brown, Davidsson & Wiklund,2001). Certain business and environmental factors pull individuals and firms towards entrepreneurial behavior or towards administrative behavior. In his early work, Stevenson categorized the management behavior of the promoter and trustee types along six dimensions: strategic orientation, commitment to opportunity, commitment of resources, control of resources, management structure and reward philosophy. He has developed his thoughts and adds two more dimensions: entrepreneurial culture, and growth orientation. According to him, entrepreneurial management is as a set of opportunity-based management practices that can help firms remain vital and contribute to firm and societal level value creation (Brown, Davidsson & Wiklund, 2001).

But those practices of entrepreneurial management are effective when Organizational Entrepreneurial Readiness is moderate to high. As study of Brown, Davidsson & Wiklund (2001) has shown that entrepreneurial management partly correlates with 'entrepreneurial orientation'. In an organization where Organizational Entrepreneurial Readiness is at its third level, managers and staff have entrepreneurial abilities, but they do not get involved or intend to do so in entrepreneurial activities due to some motivational problems. Therefore, the entrepreneurial leader should apply the Exploring Strategy (S3) and actively (activist entrepreneurial role) recognize and asses entrepreneurial opportunities outside the organization (external focus of entrepreneurial energy). Recognizing entrepreneurial opportunities by leader and participating followers on evaluation of the recognized opportunities, can motive them to conduct entrepreneurial initiatives in their firm.

Finally, the highest level of organizational entrepreneurship readiness is reached when the staff and managers possess both the willingness and the ability to engage in entrepreneurial activities (OER4). Therefore the fourth proposition is raised.

Proposition 4*: When Organizational Entrepreneurship Readiness is at its highest level (OER4), integrating strategy (S4) is the most effective entrepreneurial leadership strategy to develop corporate entrepreneurship [OER4/S4].*

When a company possesses the entrepreneurial willingness and ability at the highest level, it will definitely be entrepreneurial where managers and employees will be perfectly ready to identify and exploit entrepreneurial opportunities. As Miller (1983) and Dess and Lumpkin (2005) have argued that an entrepreneurial firm "engages in product-market innovation, under-takes somewhat risky ventures and is the first to come up with 'proactive' innovations, beating competitors to the punch" and benefit from competitive aggressiveness and autonomy. Some of the most familiar entrepreneurial firms are leading companies that create products nearly all consumers use: Sony, Panasonic, Intel, Microsoft and 3M. For insistence, 3M has been known for decades as an entrepreneurial firm that pursues growth through innovation. The 3M culture is described as non-political, low ego, egalitarian and non-hierarchical as well as hardworking and self critical (Burns, 2008). Further Virgin's emphasis on autonomy and proactiveness, and Sony's dedication to innovation and risk-taking are indicative of a strong entrepreneurial orientation -Organizational Entrepreneurship Readiness (Dess & Lumpkin,2005).

Anyway, Established mature companies at OER4, are considered major candidates for instilling corporate entrepreneurship values; mostly through developing one or more specific formal or informal structures helping to facilitate reaching their entrepreneurial goals. In such an organization, the most important role of the entrepreneurial leader is the creation of formal and informal structures for encouraging entrepreneurship and creativity. The entrepreneurial leader sets goals, monitors and integrates the entrepreneurial efforts and initiatives of his employees and managers with the overall strategy of the firm (Thornberry,2008). In fact, in an entrepreneurial organization, the leader must combine many of the traditional skills of management with entrepreneurial management. In this kind of organization, pursuing innovative ideas may be exciting but an entrepreneurial leader needs to give the firm a sense of direction and purpose by aligning these developments to the vision and direction of the organization. The entrepreneurial leader must take an overview; reconciling differing perspectives - which involves conflict resolution, creating a climate of co-operation- which will also involve co-ordination, but also exercising authority to bring forward some initiative whilst pushing back others when needed (Burns,2008)**.** In OER4 the leader should either build a shared vision that encourages risk taking and entrepreneurial mindset or support making such a shared vision (Thornberry, 2006, p.68)

Therefore the appropriate entrepreneurial leadership for all four of the Organizational Entrepreneurship Readiness (OER1-OER4) designations correspond to the following strategies: Accelerating, Mining, Exploring and Integrating strategies. Further, following the logic of Hersey and Blanchard's Situational Leadership Theory , the Situational Entrepreneurial leadership(SEL)Theory not only suggests the success probability of entrepreneurial leadership strategies at various Organizational Entrepreneurship Readiness levels, but also states the success probability of other strategies if a leader is unable to use the most desired strategy. The probability of success of each strategy for the four Organizational Entrepreneurship Readiness levels depends on how far the strategy is from the high probability strategy along the prescriptive curve in the model.

As table 4 indicates, the primary strategy as the "desired" strategy always has a "second-best" strategy choice; that is, a strategy that would probably be effective if the highest probability strategy could not be used. At the low to moderate (OER2) and moderate to high (OER3) levels there are two "second-best" strategy choices: Which one should be used depends on whether the Organizational Entrepreneurship Readiness is getting better, exploring (at OER2) and Integrating (atOER3) would be the best second choices, but if situations are deteriorating, Accelerating (at OER2) and Mining (at OER3) would be the most appropriate backup choices.

Table 5: Primary and Secondary Strategies of Entrepreneurial Leadership

Organizational Entrepreneurship Readiness(OER) Levels	Success Probability of Entrepreneurial Leadership Strategies			
	High	Moderate		Low
	Best strategy	Second best strategy	Third best strategy	Least effective strategy
OER1	Accelerating strategy	Mining strategy	Exploring strategy	Integrating strategy
OER2	Mining strategy	Accelerating strategy	Exploring strategy	Integrating strategy
OER3	Exploring strategy	Mining strategy	Integrating strategy	Accelerating strategy
OER4	Integrating strategy	Exploring strategy	Mining strategy	Accelerating strategy

As table 4 indicates, the primary strategy as the "desired" strategy always has a "second-best" strategy choice; that is, a strategy that would probably be effective if the highest probability strategy could not be used. At the low to moderate (OER2) and moderate to high (OER3) levels there are two "second-best" strategy choices: Which one should be used depends on whether the Organizational Entrepreneurship Readiness is getting better, exploring (at OER2) and Integrating (atOER3) would be the best second choices, but if situations are deteriorating, Accelerating (at OER2) and Mining (at OER3) would be the most appropriate backup choices.

Table 5 also suggests that Accelerating and Integrating strategies are risky and uncertainly ones because one of them is always the lowest probability strategy meanwhile Mining and Exploring are certain strategies because one of the two is always the moderate probability strategy. For insistence, the experiences of Louis Gerstner are a good case here. He saved IBM Corporation at a time when most people, including Gerstner himself, wondered whether the company was beyond repair. The first outsider to head the computer giant, Gerstner inherited an organization crippled by bureaucracy and created a culture that placed a premium on continually adapting business practices to better serve customers. Gerstner's fierce, competitive spirit and tough-as-nails management style were not for everyone, and Gerstner made his fair share of enemies. However he transformed IBM, from a loss-making company to a market leader (Gerstner, 2002). This case details several measures taken by Gerstner to turn IBM around including customer orientation (Integrating strategy), reducing work force, decentralizing decision making and developing e-business strategies (Accelerating strategy).

As one last thought, Entrepreneurial leadership (SEL)Theory is not the prescription of hard and fast rules. As Hersey, Blanchard and Johnson (1996) state in the behavioral sciences, there are no fixed rules. Situational Entrepreneurial leadership (SEL) Theory as a major contribution to entrepreneurship, attempts to increase the success probability of corporate Entrepreneurship programs and practices. In so doing, corporate entrepreneurs, managers and even entrepreneurial employees will be able to achieve the probability of entrepreneurial opportunity and competitive advantages they have been seeking.

9. Conclusion; Practical and Research Implications

Corporate entrepreneurship does not happen without effective leadership. The main purpose of this paper is to answer the question: "What effective entrepreneurial leadership strategies and under what conditions are effective in exploring, assessing, and exploiting the internal advantages of the company and entrepreneurial opportunities?" So far, this question has been remained unanswered in the literature of the corporate entrepreneurship. In this paper the answer is offered in the framework of contingency logic of the Situational Leadership Theory, Team Leadership and Transformational Leadership Strategies model (Narrative Review of these theories). Accordingly in this paper, the "Entrepreneurial Orientation" which is the most critical and famous concept in corporate entrepreneurship literature, is considered as the basis of situational selection of Thornberry's four entrepreneurial leadership strategies, implying "Organizational Entrepreneurship Readiness". In doing so, Thornberry's descriptive model is developed into the prescriptive phase. Selecting the effective

Entrepreneurial Leadership Strategy depends on the level of Organizational Entrepreneurship Readiness. According to Entrepreneurial Situational Leadership (ESL) Theory, the appropriate strategy of Entrepreneurial Leadership for all four of the Organizational Entrepreneurship Readiness(OER1-OER4) designations correspond to the following entrepreneurial leadership primary strategies: Accelerating , Mining ,Exploring and Integrating strategiy.

Obviously, if the entrepreneurial leader cannot or is not willing to use the entrepreneurial leadership primary strategies, the Entrepreneurial Situational Leadership (ESL) Theory suggests secondary strategies for each level. In this Theory, secondary entrepreneurial leadership strategies have been placed next to primary entrepreneurial leadership strategies on both sides.

Therefore, Entrepreneurial Situational Leadership (ESL) Theory is a practical effort to determine the method of improving Corporate Entrepreneurship by development of Organizational Entrepreneurship Readiness in established firms from the organizational leadership point of view. The analysis level in this theory is the organizational level. Hence the entrepreneurial leadership approach is situational and opportunity-oriented where opportunities typically exist inside the organization or in the environment.

To determine what Situational Entrepreneurial Leadership Strategies corporate entrepreneurs or entrepreneurial managers should use in a given situation, they must cover the below steps:

First, before managers can begin to determine the appropriate entrepreneurial leadership strategy to use in an organizational unit, they must decide what aspects of their job responsibilities they want to influence and consider. The second step is to determine the Entrepreneurship Readiness of the company in each of the selected areas. Proposed tools of Lumpkin and Dess' (1996), Koratko et al. (2005), or Thornberry's (2006) questionnaire can be used to assess the Organizational Entrepreneurial Readiness. The third step is deciding which of the four Entrepreneurial Leadership Strategies would be appropriate for Entrepreneurship Readiness of the company in each of these areas.

For further research, it is suggested to do empirical studies on the relationship between Entrepreneurial Situational Leadership Strategies and Organizational Entrepreneurship Readiness and their consequences. These studies will strengthen knowledge of corporate entrepreneurship by establishing links between entrepreneurial orientation and entrepreneurial leadership strategies. Additionally, it is suggested that in order to investigate the four propositions above, researchers consider some important moderating and control variables such as environmental uncertainty, business strategies and organizational structure. Moreover, leaders need power in order to influence their followers. Further research is needed to assess the relationship between power bases of entrepreneurial leaders and their four entrepreneurial leadership strategies. For instance, explorer leaders may need more expert and informational power than other kinds of power because the base of entrepreneurial opportunity reorganization is information asymmetry and prior experience (Shane, 2000) of entrepreneurs and corporate entrepreneurs. Understanding the role of entrepreneurial leadership in EO-performance relationships will enable us to fill this missing gap, allowing firms and organizations to function more judiciously in today's changing global environment (Todorovic & Schlosser, 2007). Finally, the study recommends designing "Entrepreneurial Leadership" as a course in Entrepreneurship Education Programs in universities.

Acknowledgement

References

[1]   Adizes, I. (1979). *How to Solve the Mismanagement Crisis*. Homewood, Illinois: Dow Jones-Irwin

[2]   Akio, T. (2005). The Critical Assessment of the Resource-Based View of Strategic Management: The Source of Heterogeneity of the Firm. *Ritsumeikan International Affairs,* 3, 125-150.

[3]   Almor, T., & Hashai, N. (2004). The competitive advantage and strategic configuration of knowledge-intensive, small- and medium-sized multinationals: a modified resource-based view. *Journal of International Management*, *10*(4), 479-500. doi:10.1016/j.intman.2004.08.002

[4]   Ardichvili, A., Cardozo, R. N., & Gasparishvili, A. (1998). Leadership styles and management practices of russian entrepreneurs: Implications for transferability of western HRD interventions. *Human Resource Development Quarterly*, *9*(2), 145-155. doi:10.1002/hrdq.3920090206

[5]   Barney, J.B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management,* 17(1), 99–120.

[6]   Baron, R., & Shane, S. (2008). *Entrepreneurship: A process perspective (2nd ed).* Mason: Thomson, South-Western.

[7]   Baumol, W. (1993). Formal entrepreneurship theory in economics: existence and bounds. *Journal of Business Venturing,* 8(3), 197–210.

[8]   Bosma, N., Jones, K., Autio, E., & Levie, J. (2007). *Global entrepreneurship monitor 2006 executive report*, Babson College: Global Entrepreneurship Research Association. Retrieved July 2, 2011, from World Wide Web: http://www.gemconsortium.org

[9]   Bosma, N., Stam, E. & Wennekers, S. (2010). Intrapreneurship: An international study. Published under EIM Research Report Intrapreneurship. Retrieved February 11, 2011 from World Wide Web: from www.eim.nl

[10]   Bouchard, V., & Basso, O. (2011). Exploring the links between entrepreneurial orientation and intrapreneurship in SMEs. *Journal of Small Business and Enterprise Development*, *18*(2), 219-231. doi:10.1108/14626001111127043

[11]   Brown, T. E., Davidsson, P., & Wiklund, J. (2001). An operationalization of Stevenson's conceptualization of entrepreneurship as opportunity-based firm behavior. *Strategic Management Journal*, *22*(10), 953-968. doi:10.1002/smj.190

[12]   Bryman, A. (2004). Qualitative research on leadership: A critical but appreciative review. *The Leadership Quarterly*, *15*(6), 729-769. doi:10.1016/j.leaqua.2004.09.007

[13]   Burns Paul (2008). *Corporate Entrepreneurship: Building the Entrepreneurial organization*, 2th edition, New York: Palgrave MacMillan

[14]   Carlile, P. R., & Christensen, C. M. (2005). The cycles of theory building in management research. Retrieved January 12, 2011 from World Wide Web: http://www.hbs.edu/research/pdf/05-057.pdf

[15]   Casson, M. (1982). *The entrepreneur : an economic theory.* Totowa, N.J.: Barnes & Noble Books.

[16]   Chen, M.-H. (2007). Entrepreneurial Leadership and New Ventures: Creativity in Entrepreneurial Teams. *Creativity and Innovation Management*, *16*(3), 239-249. doi:10.1111/j.1467-8691.2007.00439.x

[17]   Choi, E. K. (2009). Entrepreneurial leadership in the Meiji cotton spinners' early conceptualisation of global competition. *Business History*, *51*(6), 927-958. doi:10.1080/00076790903266877

[18]   Coppedge, M. (2002). Theory building and hypothesis testing: Large- vs. small-n research on democratization. Paper presented at the Annual Meeting of the Midwest Political Science Association, Chicago, Illinois.

[19]   Covin, J., & Slevin, D. (1991). A Conceptual Model of Entrepreneurship as Firm Behavior. Entrepreneurship Theory and Practice, 16(1): 7-25.

[20]   Covin, J. G. & Lumpkin. G.T. (2011). Entrepreneurial Orientation Theory and Research: Reflections on a Needed Construct. Entrepreneurship Theory And Practice. 35(5), p855-872, DOI: 10.1111/j.1540-6520.2011.00482.x

[21]   Darling, J. R., & Beebe, S. A. (2007). Effective Entrepreneurial Communication in Organization Development , *Organization Development Journal*, 25(1), 76-93.

[22]   De Jong, J. & Wennekers, S. (2008). Intrapreneurship: Conceptualizing entrepreneurial employee behavior. Published under the SCALES-initiative (SCientific AnaLysis of Entrepreneurship and SMEs), Retrieved February 11, 2012 from the World Wide Web: http://www.entrepreneurship-sme.eu/pdf-ez/H200802.pdf

[23]   Dess, G. G., Ireland, R. D., Zahra, S. A., Floyd, S. W., Janney, J. J., & Lane, P. J. (2003). Emerging Issues in Corporate Entrepreneurship. *Journal of Management*, *29*(3), 351-378. doi:10.1016/S0149-2063_03_00015-1

[24]   Dess, Gregory G. and Lumpkin G. T. (2005).Research Edge: The Role of Entrepreneurial Orientation in Stimulating Effective Corporate Entrepreneurship. The Academy of Management Executive (1993-2005), Vol. 19, No. 1 (Feb., 2005), pp.147-156

[25]   Echols, A. E., & Neck, C. P. (1998). The impact of behaviors and structure on corporate entrepreneurial success. *Journal of Managerial Psychology*, *13*(1/2), 38-46. doi:10.1108/02683949810369110

[26]   Eckhardt, J. T., & Shane, S. A. (2003). Opportunities and entrepreneurship. *Journal of Management*, 29(3), 333–349.

[27]   Editors Comments (2011). The Challenges Of Building Theory By Combining Lenses. *Academy of Management Review*. Vol. 36, No. 1, 6–11.

[28]   Engelen, A. (2010). Entrepreneurial orientation as a function of national cultural variations in two countries. Journal of International Management,16, 354-368. doi:10.1016/j.intman.2010.09.006

[29]   Elenkov, D. S., Judge, W., & Wright, P. (2005). Strategic leadership and executive innovation influence: an international multi-cluster comparative study. *Strategic Management Journal*, *26*(7), 665-682. doi:10.1002/smj.469

[30]   Ensley, M. D., Pearce, C. L., & Hmieleski, K. M. (2006). The moderating effect of environmental dynamism on the relationship between entrepreneur leadership behavior and new venture performance. *Journal of Business Venturing*, *21*(2), 243-263. doi:10.1016/j.jbusvent.2005.04.006

[31]   Fernald, Jr, L. W., Solomon, G. T., & Tarabishy, A. (2005). A new paradigm: Entrepreneurial leadership. *Southern Business Review,* 30(2), 1-10.

[32]   Fis, A. M., & Cetindamar, D. (2009). Unlocking the relationship between corporate entrepreneurship and performance (pp. 1819-1830). IEEE. doi:10.1109/PICMET.2009.5261952

[33]   Floyd, S. W., & Lane, P. J. (2000). Strategizing throughout the Organization: Managing Role Conflict in Strategic Renewal. *The Academy of Management Review,* 25(1), 154-177.

[34]   Gerstner, Louis V., Jr.(2002). *Who Says Elephants Can't Dance? Inside IBM's Historic Turnaround* , New York: Harper Business.

[35]   Gumusluoğlu, L., & Ilsev, A. (2009). Transformational Leadership and Organizational Innovation: The Roles of Internal and External Support for Innovation. *Journal of Product Innovation Management*, *26*(3), 264-277. doi:10.1111/j.1540-5885.2009.00657.x

[36]   Gupta, V., MacMillan, I. C., & Surie, G. (2004). Entrepreneurial leadership: developing and measuring a cross-cultural construct. *Journal of Business Venturing*, *19*(2), 241-260. doi:10.1016/S0883-9026(03)00040-5

[37]   Gürbüz, G., & Aykol, S. (2009). Entrepreneurial management, entrepreneurial orientation and Turkish small firm growth. *Management Research News*, *32*(4), 321-336. doi:10.1108/01409170910944281

[38] Hansen, J. D., Deitz, G. D., Tokman, M., Marino, L. D., & Weaver, K. M. (2011). Cross-national invariance of the entrepreneurial orientation scale. *Journal of Business Venturing*, *26*(1), 61-78. doi:10.1016/j.jbusvent.2009.05.003

[39] Hersey P., Blanchard, K. H., & Johnson, D. E. (1996). *Management of organizational behavior. 20th ed*, New Jersey: Prentice- Hall.

[40] Hersey, P., & Blanchard, K. (1980). *Management of organizational behavior.* New Jersey: Prentice- Hall.

[41] Hornsby, J. S., Kuratko, D. F., Shepherd, D. A., & Bott, J. P. (2009). Managers' corporate entrepreneurial actions: Examining perception and position. *Journal of Business Venturing*, *24*(3), 236-247. doi:10.1016/j.jbusvent.2008.03.002

[42] Hornsby, Jeffrey S, Kuratko, D. F., & Zahra, S. A. (2002). Middle managers' perception of the internal environment for corporate entrepreneurship: assessing a measurement scale. *Journal of Business Venturing*, *17*(3), 253-273. doi:10.1016/S0883-9026(00)00059-8

[43] Ireland, R. D., Hitt, M. A., & Sirmon, D. G. (2003). A Model of Strategic Entrepreneurship: The Construct and its Dimensions. *Journal of Management*, *29*(6), 963-989. doi:10.1016/S0149-2063_03_00086-2

[44] Klenke k. (2008). *Qualitative Research In The Study of Leadership*, Bingley, UK : Emerald Group Publishing

[45] Kreitner, R., & Kinicki, A. (2001). *Organizational Behavior (5th ed).* Burr Ridge, ILL: Irwin/McGraw-Hill.

[46] Kuratko, D. F. (2007). Entrepreneurial Leadership in the 21st Century. *Journal of Leadership and Organizational Studies*, 4(13), 1-11.

[47] Kuratko, D. F., & Hornsby, J. S. (1999). Corporate Entrepreneurial Leadership for the 21st Century. *Journal of Leadership & Organizational Studies*, *5*(2), 27-39. doi:10.1177/107179199900500204

[48] Kuratko, D. F., Hornsby, J. S., & Bishop, J. W. (2005). Managers' Corporate Entrepreneurial Actions and Job Satisfaction. The International Entrepreneurship and Management Journal, 1(3), 275-291. doi:10.1007/s11365-005-2589-1

[49] Kuratko, D. F., Morris, M. & Covin J. G. (2010). *Corporate Innovation and entrepreneurship(3th ed).* Canada: SOUTH-WESTERN CENGAGE Learning.

[50] Kuratko, D. F., & Morris, M. (2003). Corporate entrepreneurship: The dynamic strategy for 21st century organizations. *Advances in the Study of Entrepreneurship, Innovation & Economic Growth*. 14. 21-46.

[51] Ling, Y., Simsek, Z., Lubatkin, M. H., & Veiga, J. F. (2008). Transformational Leadership's Role in Promoting Corporate Entrepreneurship: Examining the CEO-TMT Interface. *The Academy of Management Journal ARCHIVE.* 51(3), 557-576.

[52] Lowe, K. B., & Gardner, W. L. (2000). Ten years of The leadership quarterly. *The Leadership Quarterly*, *11*(4), 459-514. doi:10.1016/S1048-9843(00)00059-X

[53] Lumpkin, G. T., & Dess, G. G. (1996). Clarifying the Entrepreneurial Orientation Construct and Linking It to Performance. *The Academy of Management Review, 21(1), 135-172.*

[54] Lynham, S. A. (2002). The general method of theory-building research in applied disciplines. *Advances in Developing Human Resources*, 4(3).

[55] Lyon, D. W. (2000). Enhancing Entrepreneurial Orientation Research: Operationalizing and Measuring a Key Strategic Decision Making Process. *Journal of Management*, *26*(5), 1055-1085. doi:10.1177/014920630002600503

[56] Majumdar, S., & Mukand, S. (2008). The Leader as Catalyst - On Leadership and the Mechanics of Institutional Change. *CESifo Working Paper Series*, No. 2337. Retrieved February 11, 2012 From the World Wide Web: http://ssrn.com/abstract=1156276

[57] McCarthy, D. J., Puffer, S. M., & Darda, S. V. (2010). Convergence in Entrepreneurial Leadership Style: Evidence from Russia. *California Management Review*, *52*(4), 48-72. doi:10.1525/cmr.2010.52.4.48

[58]   McGrath, R. G., & MacMillan, I. (2000). *The entrepreneurial mindset.* Boston, MA: Harvard Business Press.

[59]   Merrill, R. E., & Sedgwick, H. D. (1995). The six styles of entrepreneurial leadership. Retrieved from the World Wide Web: http://www.turnaround.org/Publications/Articles.aspx?objectID=2676

[60]   Miller, D. (1983). The Correlates of Entrepreneurship in Three Types of Firms. *Management Science,* 29(7), 770-791.

[61]   Miller, D., & Friesen, P. (1982). Innovation in conservative and entrepreneurial firms: Two models of strategic momentum. *Strategic Management Journal,* 3(1), 1-25.

[62]   Mintzberg, H. (1973). *The nature of managerial work*, New York: Harper & Row

[63]   Morris, M. (1996). The concept of entrepreneurial intensity: Implications for company performance. *Journal of Business Research*, *36*(1), 5-13. doi:10.1016/0148-2963(95)00158-1

[64]   Morris, M. H., Kuratko, D. F., & Covin, J. G. (2011). *Corporate entrepreneurship and innovation : entrepreneurial development within organizations*. Mason, OH: South-Western Cengage Learning.

[65]   Pearce, J. A., Kramer, T. R., & Robbins, D. K. (1997). Effects of managers' entrepreneurial behavior on subordinates. *Journal of Business Venturing*, *12*(2), 147-160. doi:10.1016/S0883-9026(96)00066-3

[66]   Politis, J. D., & Politis, D. J. (2009). The relationship of mainstream leadership styles to entrepreneurial orientation. In the proceedings of The 5th European Conference on Management, Leadership and Governance (ECMLG 2009), pp. 202-211. Hellenic American University & ATExcelixi, Athens, Greece.

[67]   Randerson, K., & Fayolle, A. (2009). Entrepreneurial Orientation and Entrepreneurial Management : Same, Different, or Both? paper presented at RENT, Budapest, Hungary

[68]   Rauch, A. J., Wiklund, J., Lumpkin, G. T., & Frese, M. (2009). Entrepreneurial orientation and business performance: an assessment of past research and suggestions for the future. *Entrepreneurship Theory and Practice*, 33(3), 761-788.

[69]   Rauch, A., & Frese, M. (2009). Entreprfeneurial Orientation, in A. Bausch & B. Schwenker (eds), *Handbook of utility management*, Berlin, Heidelberg: Springer_Verlag.

[70]   Reio, T. G. (2010). The ongoing quest for theory-building research methods articles. *Human Resource Development Review*, 9(3), 223-225.

[71]   Ripoll, M. M., Rodríguez, F. G., Barrasa, & Antino, A., M. (2010). Leardership in entrepreneurial organizations: context and motives. *Psicothema,* 22(4), 880-886.

[72]   Santora, J. C., Seaton, W., & Sarros, J. C. (1999). Changing Times: Entrepreneurial Leadership In A Community-Based Nonprofit Organization. *Journal of Leadership & Organizational Studies*, *6*(3-4), 101-109. doi:10.1177/107179199900600308

[73]   Sarros, J. C., Cooper, B. K., & Santora, J. C. (2008). Building a Climate for Innovation Through Transformational Leadership and Organizational Culture. *Journal of Leadership & Organizational Studies*, *15*(2), 145-158. doi:10.1177/1548051808324100

[74]   Scheepers, J., Hough, J., & Bloom, J. Z. (2008). Nurturing The Corporate Entrepreneurship Capability.*Southern African Business Review*, 12(3). 50-75.

[75]   Shane S. (2000). Prior Knowledge and the Discovery of Entrepreneurial Opportunities. *Organization Science,* 11(4), 448-469.

[76]   Shane, S., & Venkataraman, S. (2000). The Promise of Entrepreneurship as a Field of Research. *The Academy of Management Review*, 25(1), 217-226.

[77]   Soriano, D. R., & Martínez, J. M. C. (2007). Transmitting the entrepreneurial spirit to the work team in SMEs: the importance of leadership. *Management Decision*, *45*(7), 1102-1122. doi:10.1108/00251740710773934

[78]   Stevenson, H. H., & Jarillo, J. C. (1990). A paradigm of entrepreneurship: Entrepreneurial management. *Strategic Management Journal*, 11, 17-27.

[79] Tarabishy A., & Fernald, L. W. (2003). Identifying Entrepreneurial Leaders in Today's Dynamic Markets. Retrieved February 11, 2012 From the World Wide Web: http://usasbe.org/knowledge/proceedings/proceedingsDocs/USASBE2004proceedings-Tarabishy.pdf

[80] Tarabishy, A., Fernald, L. W., & Solomon, G. T. (2003). Understanding entrepreneurial leadership in today's dynamic markets. Retreived February 11, 2012 From www. http://usasbe.org/knowledge/proceedings/proceedingsDocs/USASBE2003proceedings-21.pdf

[81] Thornberry, N. (2006). Lead like an entrepreneur. New York: McGraw-Hill.

[82] Todorovic, E. W., & Schlosser, F. K. (2007). An entrepreneur and a leader!: A framework conceptualizing the influence of leadership style on a firm's entrepreneurial orientation—performance relationship. *Journal of Small Business and Entrepreneurship,* 20(3), 289–308.

[83] Torraco, R. J. (2002). Research Methods for Theory Building in Applied Disciplines: A Comparative Analysis. *Advances in Developing Human Resources*, *4*(3), 355-376. doi:10.1177/1523422302043008

[84] Turnbull, S. (2002). Social Construction Research and Theory Building. *Advances in Developing Human Resources*, *4*(3), 317-334. doi:10.1177/1523422302043006

[85] Vecchio, R. (2003). Entrepreneurship and leadership: common trends and common threads. Human Resource Management Review. doi:10.1016/S1053-4822(03)00019-6

[86] Winkler I.(2010). *Contemporary Leadership Theories*. Sønderborg ,Denmark : Springer-Verlag Berlin Heidelberg

[87] Yang, C.W. (2008). The relationships among leadership styles, entrepreneurial orientation and business performance. *Managing Global Transitions*, 6(3), 257–275.

[88] Zahra, S. A. (2007). Contextualizing theory building in entrepreneurship research. Journal of Business Venturing, 22(3), 443-452. doi:10.1016/j.jbusvent.2006.04.007