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From Editor

In this issue of "International Journal of Electronics, Mechanical and Mechatronics Engineering (IJEMME)", we have especially selected the scientific areas which will cover future prospective Engineering titles such as Robotics, Mechanics, Electronics, Telecommunications, Control systems, System Engineering, Biomedical, and renewable Energy Sources.

We have selected only a few of the manuscripts to be published after a peer review process of many submitted studies. Accepted papers are as follows:

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Prof. Dr. Osman N. UCAN
Editor in Chief

Event Reconstruction By Inverse Methods

Olugboji Oluwafemi Ayodeji[1]
Jiya Jonathan Yisa[2]

Abstract
This work deals with an inversion technique that was developed to reconstruct a pulse after it has propagated along a pipe; a complex pulse that is progressively distorted as explained. The technique developed makes use of the theory of inverse problems.

Keywords: *Pulse, event, inverse method, deconvolution, sensor,*

Introduction
An inverse problem is one that occurs in many branches of science and mathematics where the values of some model parameter(s) must be obtained from the observed data. Inverse methods can be basically considered as an approach for interpolating or smoothing a data set in space and time where a model acts as a dynamical constraint [1].

An inverse problem involves determining the parameters of a model that describes or explains a set of observed data.

In geophysics, inverse problems require an understanding of the "forward process" that relates the model to its geophysical response. They also require knowledge of the statistical reliability of the observed data. Aspects that must be considered in inverse problems include the formulation and parameterization of the problem, the existence, uniqueness and resolution of solutions, strategies for dealing with over-determined and under-determined model parameters, and strategies for introducing independent constraints into the solutions [2].

Forward Theory
The (mathematical) process of predicting data based on some physical or mathematical model with a given set of model parameters (and perhaps some other appropriate information, such as geometry, etc.).
As an example, consider a two-way vertical travel time t of a seismic wave through M, *layers* of thickness h_i and velocity v_i. Then t is given by:

$$t = 2\sum_{i=1}^{M} \frac{h_i}{v_i}.$$

The forward problem consists of predicting data (travel time) based on a (mathematical) model of how seismic waves travel. Suppose that for some reason thickness was known for each layer (perhaps from drilling). Then only the M

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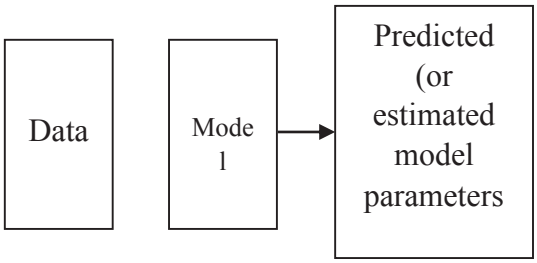
velocities would be considered model parameters. One would obtain a particular travel time t for each set of model parameters one chooses.
Schematically, one might represent this as follows:



As an example, one might invert the travel time t above to determine the layer velocities. Note that one needs to know the (mathematical) model relating travel time to layer thickness and velocity information. Inverse theory should not be expected to provide the model itself.

The work as carried out by this research is made more difficult as there are no possibilities of making repeat trials, but fortunately this is made possible because the pulses propagate in a one-dimensional wave guide rather than the three dimensional interior of the Earth.

The Inverse Theory

Inverse problems may be described as problems where the solutions are known, but not the causes. Alternatively, where the results, or consequences of the problem are known but not what must have caused it. Inverse theory therefore requires knowledge of a forward model capable of predicting data if the model parameters are already known. In an inverse problem measurements are taken of these effects and calculations made to establish what caused them. This requires a description of the data; in most inverse problems the data are simply a table of numerical values, of which a vector provides a convenient means of representing them.

Inverse theory is inherently mathematical and as such does have its limitations. It is best suited to estimating the numerical values of model parameters for some known or assumed mathematical model. It is good for extracting the model parameters that best fit the data.

The basic theory of inverse methods is fully explained by Menke [3]. Briefly, it can be summarised as follows. Suppose in the course of an experiment N measurements are obtained, these numbers may be considered as the elements of the vector **d** of length N. Also, the model parameters can be represented as the elements of the vector **m**, of length M.
Thus, we can write,

data: $\mathbf{d} = [d_1, d_2, d_3 ..., d_N]^T$ (1)

model parameters:

$\mathbf{m} = [m_1, m_2, m_3, ..., m_M]^T$ (2)

In the statement of an inverse problem there is a relationship between the model parameters and the data. This relationship is referred to as the model. The model usually takes the form of one or more formulas that the model parameters and data are anticipated to follow. For example, in trying to determine the resistance of a wire by measuring its voltage and current, there will be two data sets, voltage $\mathbf{d}_1$ and current $\mathbf{d}_2$ respectively, and one unknown model parameter, resistance (m_1). The model statement would be the resistance times the current equals voltage, which can be represented compactly by vector equation (3),

$\mathbf{d}_1 = \mathbf{d}_2 m_1$ (3)

In more realistic situations the relationship between the data and model parameter is more complicated. In the most general case, the data and model parameters are related by one or more implicit equation such as in equation (4),

$$l_1(\mathbf{d}, \mathbf{m}) = 0$$
$$l_2(\mathbf{d}, \mathbf{m}) = 0$$
$$\vdots \qquad (4)$$
$$l_N(\mathbf{d}, \mathbf{m}) = 0$$

where, N is the number of equations.
In the above problem concerning the measurements of the resistance, $N = 1$ and $d_2 m_1 = d_1$ would constitute one equation of the form

$$l_1(\mathrm{d}, \mathrm{m}) = 0 \qquad (5)$$

These implicit equations, which can be compactly written as the vector equation **l** (**d**, **m**) = 0, summarize what is known about how the measured data and the unknown model parameter are related. The goal of inverse theory, therefore, is to solve, or invert, these equations for the model parameters.

The Linear Inveerse Problem

The simplest form of a linear inverse problem as described by Menke [3], is given by,

$$\mathbf{d} = \mathbf{Gm} \qquad (6)$$

where,
d = measured data, **G** = data kernel **m** = model parameters
The data and model parameters are functions $d(x)$ and $m(x)$, in which x is some independent variable. Again using the problem of determining the resistance of a wire it is possible to formulate an inverse problem. Supposing that N voltage measurements V_j are made at current i_j in a circuit, then, the data form a vector **d** of N measurements of voltage, where,

$$\mathbf{d} = [V_1, V_2, V_3, \ldots, V_N]^T \qquad (7)$$

The current i_j provides auxiliary information that describes the geometry of the experiment. If we assume a model in which the voltage is a linear function of the current;

$$V = a + bi \qquad (8)$$

The intercept a and the slope b form the two model parameters of the problem, m $= [a, b]^T$.

According to this model, each voltage observation must satisfy $V = a + bi$:

$$\begin{aligned} V_1 &= a + bi_1 \\ V_2 &= a + bi_2 \\ &\vdots \\ V_N &= a + bi_N \end{aligned} \qquad (9)$$

These equations can be arranged as the matrix equation **d** = **Gm**:

$$\underbrace{\begin{bmatrix} V_1 \\ V_2 \\ . \\ . \\ . \\ V_N \end{bmatrix}}_{d} = \underbrace{\begin{bmatrix} 1 & i_1 \\ 1 & i_2 \\ . & . \\ . & . \\ . & . \\ 1 & i_N \end{bmatrix}}_{G} \underbrace{\begin{bmatrix} a \\ b \end{bmatrix}}_{m} \qquad (10)$$

For any real set of measurements with experimental errors equation (8) will not be satisfied exactly, but equation 10 can still be used for a least square solution to determine the model parameters *a* and *b*.

Inverse Method Based On Least Squares

The two most common vectors that are concerned with inverse problems are the data-error or misfit vector and the model parameter vector [3]. The methods based on data-error or misfit give rise to classic least squares solutions, while methods based on the model parameter give rise to what is called minimum length solutions.

The improvements over simple least squares and the minimum length solutions include the use of information about noise in the data and a fore-knowledge about the model parameters.

The most important application of these vectors is in data fitting. The best fit in the least square sense minimizes the sum of the squared residuals, a residual being the difference between an

observed value and the fitted value provided by a model.

Minimizing the Misfit-Least Squares (after Menke [3])

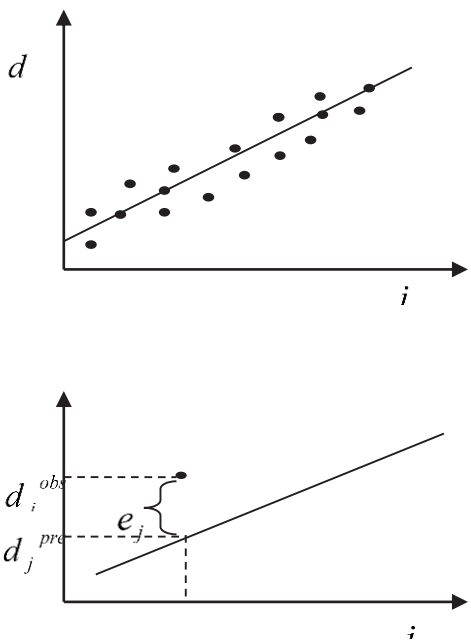


Figure 1 Least squares fitting of a straight line to (i, d) pairs

The error e_j for each observation is the difference between the observed and predicted datum:

$$e_j = d_j^{obs} - d_j^{pre} \tag{11}$$

The jth predicted datum d_j^{pre} for the straight line problem is given by

$$d_j^{pre} = m_1 + m_2 i_j \tag{12}$$

where the two unknowns, m_1 and m_2, are the intercept and the slope of the line and i_j is the value along the i axis where the jth observation is made.

For N points we have a system of N such equations that can be written in matrix form as:

$$\begin{bmatrix} d_1 \\ . \\ . \\ . \\ d_N \end{bmatrix} = \begin{bmatrix} 1 & i_1 \\ . & . \\ . & . \\ . & . \\ 1 & i_N \end{bmatrix} \begin{bmatrix} m_1 \\ m_2 \end{bmatrix} \tag{13}$$

or

$$\underset{(N\times 1)}{\mathbf{d}} = \underset{(N\times 2)}{\mathbf{G}} \; \underset{(2\times 1)}{\mathbf{m}} \tag{14}$$

The total misfit E is given by

$$E = \mathbf{e}^{\mathrm{T}}\mathbf{e} = \sum_{j=1}^{N} \left[d_j^{obs} - d_j^{pre} \right]^2 \tag{15}$$

$$= \sum_{j=1}^{N} \left[d_j^{obs} - (m_1 + m_2 i_j) \right]^2 \tag{16}$$

Dropping the "obs" in the notation for the observed data, we have

$$E = \sum_{j}^{N} \begin{bmatrix} d_j^{\,2} - 2d_j m_1 - 2d_j m_2 i_j + \\ 2m_1 m_2 i_j + m_1^{\,2} + m_2^{\,2} i_j^{\,2} \end{bmatrix} \tag{17}$$

Taking the partial derivatives of E with respect to m_1 and m_2, and equating them to zero yields:

$$\frac{\partial E}{\partial m_1} = 2Nm_1 - 2\sum_{j=1}^{N} d_j + 2m_2 \sum_{j=1}^{N} i_j = 0 \tag{18}$$

And

$$\frac{\partial E}{\partial m_2} = -2\sum_{j=1}^{N} d_j i_j + 2m_1 \sum_{j=1}^{N} i_j + 2m_2 \sum_{j=1}^{N} i_j^{\,2} = 0 \tag{19}$$

Rewriting equations (5.18) and (5.19) above

$$Nm_1 + m_2 \sum_j i_j = \sum_j d_j \qquad (20)$$

and

$$m_1 \sum_j i_j + m_2 \sum_j i_j^{\,2} = \sum_j d_i i_j \qquad (21)$$

Combining the two equations in matrix notation in the form **Am** = **b** gives

$$\begin{bmatrix} N & \sum i_j \\ \sum i_j & \sum i_j^{\,2} \end{bmatrix} \begin{bmatrix} m_1 \\ m_2 \end{bmatrix} = \begin{bmatrix} \sum d_j \\ \sum d_j i_j \end{bmatrix} \qquad (22)$$

or, simply

$$\underset{(2\times 2)}{\mathbf{A}} \quad \underset{(2\times 1)}{\mathbf{m}} \quad = \quad \underset{(2\times 1)}{\mathbf{b}} \qquad (23)$$

Equation (23) above shows that the problem has been reduced from one with N equations to two unknowns (m_1 and m_2) in **Gm** = **d** to one with two equations in the same unknowns as in **Am** = **b**.

The matrix equation **Am** = **b** can also be rewritten in terms of the original **G** and **d** when it is observed that the matrix **A** can be factored as:

$$\begin{bmatrix} N & \sum i_j \\ \sum i_j & \sum i_j^{\,2} \end{bmatrix} = \begin{bmatrix} 1 & 1 & \dots & 1 \\ i_1 & i_2 & \dots & i_N \end{bmatrix} \begin{bmatrix} 1 & i_1 \\ 1 & i_2 \\ . & . \\ . & . \\ . & . \\ 1 & i_N \end{bmatrix} = \mathrm{G^T G}$$

(24)

Also, **b** above can be written similarly as

$$\begin{bmatrix} \sum d_j \\ \sum d_j i_j \end{bmatrix} = \begin{bmatrix} 1 & 1 & \dots & 1 \\ i_1 & i_2 & \dots & i_N \end{bmatrix} \begin{bmatrix} d_1 \\ d_2 \\ . \\ . \\ . \\ d_N \end{bmatrix} = \mathrm{G^T d}$$

(25)

Substituting equations (24) and (25) into equation (22), gives the equations for the least squares problem:

$$\mathbf{G^T G m} = \mathbf{G^T d} \qquad (26)$$

The least squares solution $\mathbf{m_{LS}}$ is then obtained as

$$\mathbf{m_{LS}} = [\mathbf{G^T G}]^{-1}\mathbf{G^T d} \qquad (27)$$

assuming that $[\mathbf{G^T G}]^{-1}$ exists.

This solution implies that the forward problem as in equation (13) can be used to obtain an explicit relationship between the model parameters (m_1 and m_2) and a measurement of the misfit to the observed data E. The value E is then minimized by taking the partial derivatives of the misfit function with respect to the unknown model parameters, equating the partial derivatives

to zero, and solving for the model parameters [4].

Application Of Linear Inverse To Pulse Propagation In Pipelines

Consider again the pipeline illustrated in Figure 2 To formulate the problem into a least-squares inverse problem, we can use the rule governing the attenuation between sensors 2 and 3: that the attenuation coefficient defining propagation is not only frequency dependent, but is proportional to frequency squared [5], and then work backwards from sensor 2 to the event site. Though pulse propagation in a pipeline is in reality non-linear, it is only weakly so if the dispersion effect is not too strong. In this section the assumption of local linearity is made by neglecting dispersion, and so that the problem can be approached by the least–squares inverse method.

The technique developed works in the frequency domain. The pulse signals at the sensor locations 2 and 3 are first transformed into the frequency domain using the fast fourier transform (FFT). Assuming exponential attenuation proportional to the square of each frequency component a best-fit coefficient for the attenuation between locations 2 and 3 is found. Applying this to the pulse signal from sensor 2 the original pulse at the event site is reconstructed in the frequency domain, and finally transformed back into the time domain using the inverse FFT.

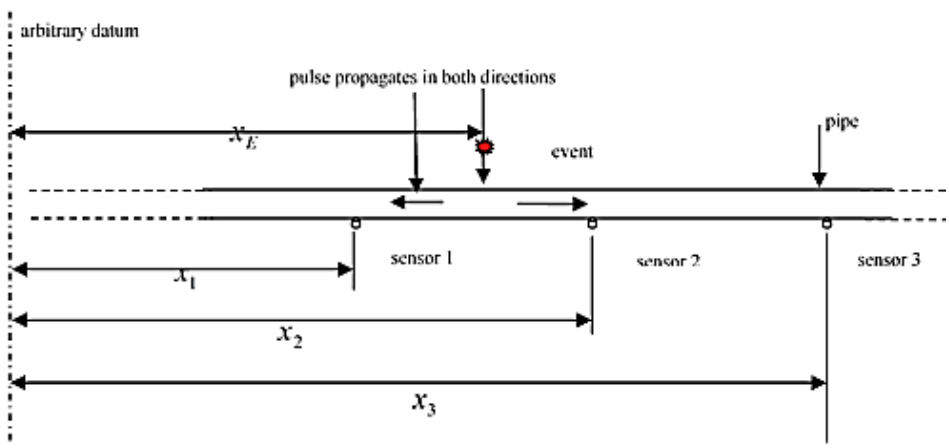


Figure 2 Schematic representation of sensors on a pipeline

Pulses propagating in fluid filled pipelines can be expressed in the form:

$$p(x,t) = p_o(t)\exp(-\beta x) \tag{28}$$

where p is the description of the pulse which is a function of time and distance along the pipe, p_o is the function defining the pulse at $x = 0$, β is frequency dependent attenuation factor, proportional to frequency squared. This formulation is general and is not restricted to any particular pulse shape.

Relating this to the Fourier spectrum in the frequency domain,

$$P_j^{\,1} = P_j^{\,0} e^{-\beta x_{0,1}} \tag{29}$$

or

$$P_j^{\,1} = P_j^{\,0} e^{-a f_j^{\,2} x_{0,1}} \tag{30}$$

Where $P_j^{\,0}$ and $P_j^{\,1}$ are the pulse functions transformed into the frequency domain, the subscripts denoting the index of the Fourier spectrum components and the superscripts the location of the pulse, 0 being the event location and 1, 2, 3 being locations of the sensors as defined in Figure 2.

f_j = the frequency of the jth Fourier component,
$x_{0,1}$ = distance between the event 0 and sensor 1.
a = a proportionality constant to be determined

Considering now, the Fourier spectrums of the pulse signals at sensors 2 and 3 along the pipeline in Figure 2,

$$P_j^{\,3} = P_j^{\,2} e^{-a f_j^{\,2} x_{2,3}} \tag{31}$$

Taking the natural logarithm of both sides of the expression in equation 31 makes this into a linear inverse problem of the form,

$$LnP_j^{\,2} = LnP_j^{\,3} + a f_j^{\,2} x_{2,3} \tag{32}$$

In matrix form, this becomes:

$$\underbrace{\begin{bmatrix} LnP_1^{\,2} \\ LnP_2^{\,2} \\ . \\ . \\ . \\ LnP_N^{\,2} \end{bmatrix}}_{d} = \underbrace{\begin{bmatrix} LnP_1^{\,3} & x_{2,3} f_1^{\,2} \\ LnP_2^{\,3} & x_{2,3} f_2^{\,2} \\ . & . \\ . & . \\ . & . \\ LnP_N^{\,3} & x_{2,3} f_N^{\,2} \end{bmatrix}}_{G} \underbrace{\begin{bmatrix} 1 \\ a \end{bmatrix}}_{m} \tag{33}$$

which is of the same basic form as equation 13. Forming the matrix products

G^{T}**G=**

$$\begin{bmatrix} LnP_1^{\,3} & LnP_2^{\,3} & . . . & LnP_N^{\,3} \\ x_{2,3} f_1^{\,2} & x_{2,3} f_2^{\,2} & . . . & x_{2,3} f_N^{\,2} \end{bmatrix} \begin{bmatrix} LnP_1^{\,3} & x_{2,3} f_1^{\,2} \\ LnP_2^{\,3} & x_{2,3} f_2^{\,2} \\ . & . \\ . & . \\ . & . \\ LnP_N^{\,3} & x_{2,3} f_N^{\,2} \end{bmatrix}$$

$$= \begin{bmatrix} \sum (LnP_j^{\,3})^2 & \sum (LnP_j^{\,3} \times x_{2,3} f_j^{\,2}) \\ \sum (x_{2,3} f_j^{\,2} \times LnP_j^{\,3}) & \sum x_{2,3}^{\,2} f_j^{\,4} \end{bmatrix}$$

(34) and

$$\mathbf{G}^{\mathrm{T}}\mathbf{d} = \begin{bmatrix} LnP_1^{\,3} & LnP_2^{\,3} & . . . & LnP_N^{\,3} \\ x_{2,3} f_1^{\,2} & x_{2,3} f_2^{\,2} & . . . & x_{2,3} f_N^{\,2} \end{bmatrix} \begin{bmatrix} LnP_1^{\,2} \\ LnP_2^{\,2} \\ . \\ . \\ . \\ LnP_N^{\,2} \end{bmatrix} =$$

$$\begin{bmatrix} \sum (LnP_j^{\,3} \times LnP_j^{\,2}) \times x_{2,3} f_j^{\,2} \\ \sum x_{2,3} f_j^{\,2} LnP_j^{\,2} \end{bmatrix}$$

$$\mathbf{m}_{LS} = [\mathbf{G}^T\mathbf{G}]^{-1}\mathbf{G}^T\mathbf{d} \tag{35}$$

$$= \begin{bmatrix} \sum (LnP_j^{\,3})^2 & \sum (LnP_j^{\,3} \times x_{2,3} f_j^{\,2}) \\ \sum (x_{2,3} f_j^{\,2} \times LnP_j^{\,3}) & \sum x_{2,3}^{\,2} f_j^{\,4} \end{bmatrix}^{-1} \begin{bmatrix} \sum (LnP_j^{\,2} \times LnP_j^{\,3}) \times x_{2,3} f_j^{\,2} \\ \sum x_{2,3} f_j^{\,2} LnP_j^{\,2} \end{bmatrix} \tag{36}$$

Equation (36) gives a linear solution to the least square inverse problem obtained based on the general form of the solution set out, from which the estimate of the model parameter a, which defines the frequency dependent attenuation in $\mathbf{m}_{LS} = [1 \;\; a]^T$ is determined. This value of the estimated model parameter a in $\mathbf{m}_{LS}$ can then be applied to the Fourier spectrum of the pulse signal at sensor 2 to compute the estimated Fourier spectrum of the form of the pulse to be reconstructed at the start of the event using equation (33)

$$\underbrace{\begin{bmatrix} LnP_1^{\,0} \\ LnP_2^{\,0} \\ . \\ . \\ . \\ LnP_N^{\,0} \end{bmatrix}}_{d} = \underbrace{\begin{bmatrix} LnP_1^{\,2} & x_{0,2} f_1^{\,2} \\ LnP_2^{\,2} & x_{0,2} f_2^{\,2} \\ . & . \\ . & . \\ . & . \\ LnP_N^{\,2} & x_{0,2} f_N^{\,2} \end{bmatrix}}_{G} m_{LS} \tag{37}$$

Since, the Fourier spectrum of the pulse signal at sensor 2 is known, this allows for the computation of the log Fourier spectrum of the pulse at the event that is to be reconstructed, and from which it is a simple matter to convert to the time domain using the inverse FFT.

Reconstruction Of Simple Pulse By The Inverse Method

This involved the use of the simple pulse data described containing a single frequency component of 53 Hz.

- Case 1: close sensor spacing of 110 m from the event site to sensor 2 and 300 m between sensors 2 and 3.

Figures 3 and 4 show the reconstructed pulses obtained using the inverse method.

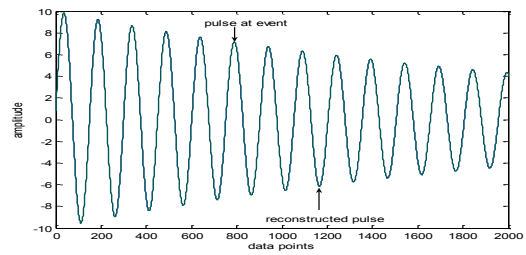
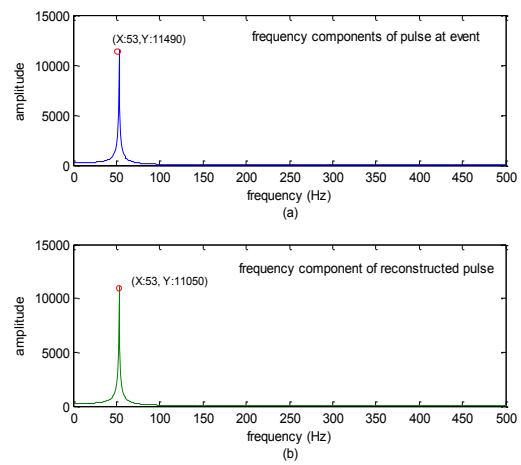


Figure 3. *Reconstructed simulated pulse at event by inverse method (single frequency with sensors close to the event) in time domain*



(a) original pulse (b) reconstructed pulse

Figure 4 Reconstructed simulated pulse at event by inverse method (single frequency with sensors close to the event) in time domain

The reconstructed pulse in Figure 3 shows a good fit to the original pulse. This impression is confirmed by the Fourier spectra of the pulses in Figure 4, which have the same fundamental frequency of 53 Hz and differ by only 4% in magnitude compared with the 7% using the deconvolution filter method.

Case 2: wide sensor spacing of 800 m from the event site to sensor 2 and 1000 m between sensors 2 and 3

Figures 5 and 6 shows the simple pulse reconstructed by the inverse method in the time and frequency domains, respectively.

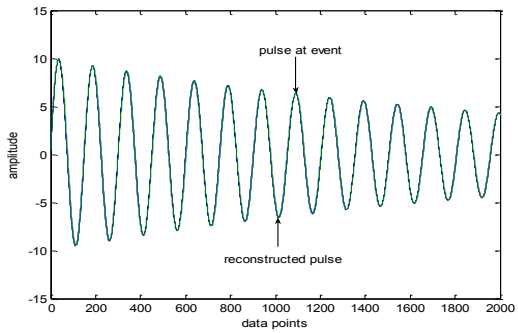
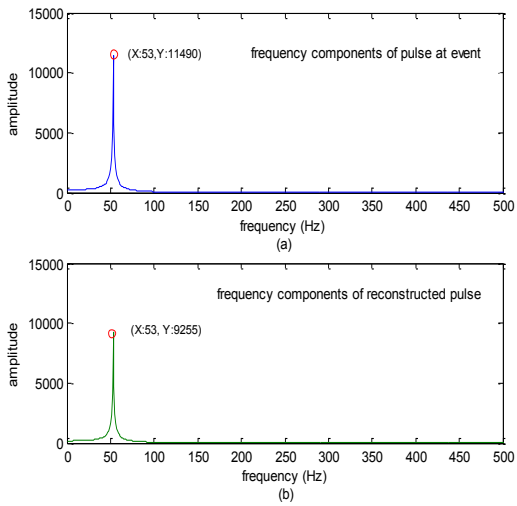


Figure 5. *Reconstructed simulated pulse at event by inverse method (single frequency with sensors widely spaced) in time domain*



(a) original pulse (b) reconstructed pulse

Figure 6 Reconstructed simulated pulse at event by inverse method (single frequency with sensors widely spaced) in frequency domain

The fit of the reconstructed pulse with the original looks better using the inverse method, though this impression is not confirmed by Figure 5 where the height of the 53Hz peak is 20% different from the original, compared with 15% using the deconvolution filter.

Complex Pulse Reconstruction By Inverse Method

This entailed the reconstruction of a complex pulse with eight frequency components as described under the same conditions of cases 1 and 2.

- Case 1: closely spaced sensors

Figures 7 and 8 shows the reconstructed pulses obtained using the inverse method under the conditions of case 1.

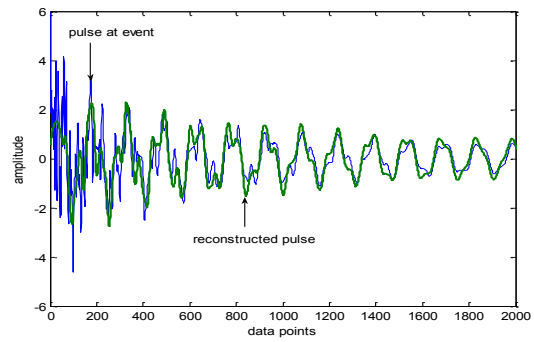
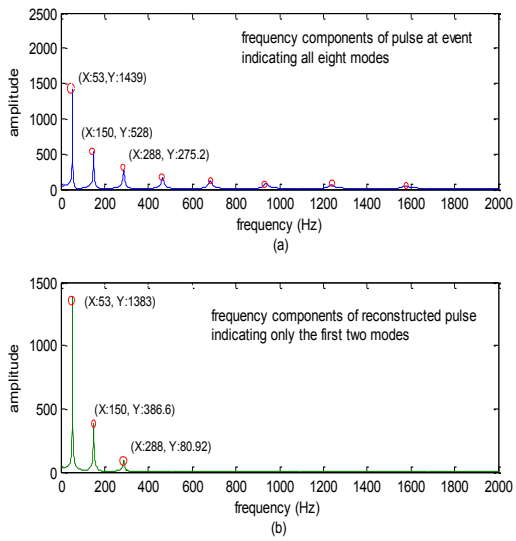


Figure 7. *Reconstructed simulated pulse at event by inverse method (multiple frequencies with sensors closer to the event) in time domain*

The reconstructed pulse in Figure 7 using the inverse method shows a better approximation to the original pulse than that obtained using the deconvolution filter. This is confirmed in Figure 8 where the first three peaks reduce in a similar progression. The magnitude of these three low modes are all underestimated by this inverse reconstruction technique, and this effect is progressively more marked in the higher frequency modes so that the fourth and subsequent modes are not reconstructed at all. As in the deconvolution filter reconstruction method, this is because these components attenuate fast and so did not reach the second sensor, so they would not have appeared in the inverse calculation.



(a) original pulse (b) reconstructed pulse

Figure 8. *Reconstructed simulated pulse at event by inverse method (multiple frequencies with sensors closer to the event) in frequency domain*

- Case 2: widely spaced sensors

Reconstruction of the same complex pulse with the widely spaced sensors is shown in Figures 9 and 10 in the time and frequency domains.

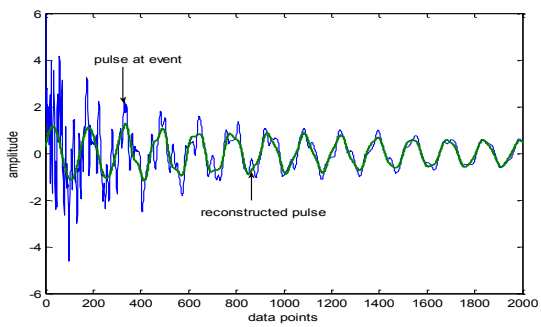
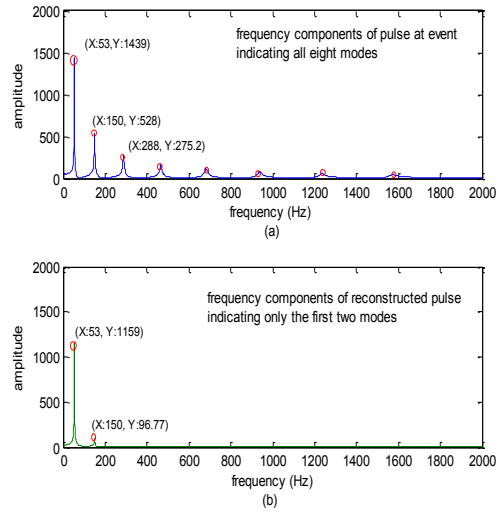


Figure 9. Reconstructed simulated pulse at event by inverse method (multiple frequencies with sensors far apart to the event) in time domain



(a) original pulse (b) reconstructed pulse

Figure 10 Reconstructed simulated pulse at event by inverse method (multiple frequencies with sensors far apart to the event) in frequency domain

From Figure 9 it can be seen that virtually all the high frequency components in the original simulated pulse at the event are not seen in the reconstructed pulse, and this is confirmed in Figure 10 where only the first two modal peaks of the reconstructed pulse are visible, and the second is very small. Nevertheless, even with this very wide sensor spacing and the very limited signal produced at the more remote sensor the reproduced pulse does still contain useful information about the magnitude and decay rate of the original pulse. From these test results obtained using the developed pulse propagation model, it is evident that the inverse method of pulse reconstruction gives better results than the deconvolution filter method. However, it should be noted that the inverse method consistently underestimated the pulse magnitude, whereas the deconvolution filter overestimated it, so there could be a case for using both methods in a practical application to obtain the best possible estimate.

Experimental Work And Results

To investigate the use of inverse methods in the reconstruction of the pulse at the event site, the event to be reconstructed was similarly taken as the pulse as it passes through the first sensor. As before, the pressure pulse data at the first sensor was recorded but not used in the subsequent calculations. The same pressure pulse measurements obtained from sensors 2 and 3, and , in the previous section were used and later transformed into the frequency domain using the fast Fourier transform (FFT) function in Matlab to obtain their respective Fourier spectra. Based on the Fourier spectrum of the measured pressure pulses, a solution to the least square inverse problem was obtained to determine the estimate of the required model parameter mLS following the procedures outlined. This value of the estimated model parameter was then used to calculate the Fourier spectrum of the pressure pulse to be reconstructed. The exponential of the log Fourier spectrum was then taken
and transformedinto the time domain using the inverse fast Fourier transform (IFFT) function in Matlab

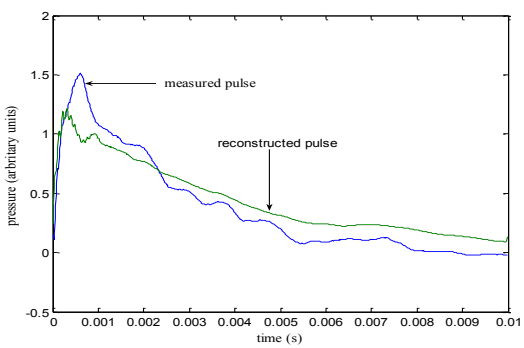


Figure 11. *Reconstructed pulse at sensor 1 by inverse method*

From Figure 11 the shapes of the reconstructed and measured original pulse at sensor 1 agree quite well. The magnitude of the reconstructed pulse in this case can be seen to have underestimated the measured pulse by 20%. This result is typical of the fifteen repeat tests, in which the underestimate ranged between 20 % and 22 %.

These experimental results are consistent with the model results which gave a similar level of underestimation.

REFERENCES

[1] Inverse methods and data Assimilation in Nonlinear Ocean models Geir Evensen

[2] Nansen Environmental and remote Sensing Center,Bergen, Norway Physica D,in July,1994.

[3] Ferguson, I. J. “Theory and Application of Geophysical Inversion Methods “

[4] Department of Geological Sciences University of Manitoba 2005 page 1.

[5] Menke, W. “Geophysical Data Analysis: Discrete Inverse Theory”. Academic Press. Orlando, 1984.

[6] U.S. Department of Transportation, Research and Special Program Administration, 2003, “Pipeline Integrity Management in High Consequence Areas (Gas Transmission Pipelines)’’.

[7] Cao, C.F, Baik, S., Choi, J.B and Kim, Y.J. “Protection of Underground Gas

[8] Pipelines from Third Party Damage by On-Line Monitoring Using Piezoelectric Accelerometers”. Proceedings of the Institution of Mechanical Engineers, Part E:Journal of Process Mechanical Engineering. Volume 221, pages 61 – 67.

Investigation Of The Effect Of The Dyeing Method On The Dyeing Properties Of Silk Fabric Dyed With Natural Dye

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Abstract

In this study, silk fabric was dyed with the natural dye extracted from blueberry (Vaccinium corymbosum L.) via ultrasonic, microwave and conventional methods. One of the samples dyed via conventional method was treated oxygen plasma treatment whereas the other was mordanted with aluminium potassium sulphate prior to the dyeing process. The colour and fastness properties of the dyed fabrics were investigated and compared with each other in terms of dyeing method. The physical structure of samples was analysed with scanning electron microscope (SEM). The chemical structure of samples was characterized by Fourier transform infrared spectroscopy (FTIR ATR). According to the results, the samples dyed via microwave method had the best results in terms of colour properties. Furthermore, when compared with one another in terms of dyeing methods, there were no significant differences between fastness properties of dyed samples.

Keywords: *Vaccinium Corymbosum L., Ultrasonic Method, Microwave Method, Conventional Method, Plasma Treatment, Fastness Properties.*

1. Introduction

In textile dyeing industry, in comparison to natural dyes, synthetic dyes have been prevalently used due to their lower prices, a wide range of colour and better fastness properties [1,2]. However, one should have regard to the significant though often overlooked issue which synthetic dyes are toxic, carcinogenic, non-biodegradable [3]. In addition, synthetic dyes cause environmental pollution and waste water problem[3]. Recently, the dye industry has been endeavouring to reduce toxic effluents and to stop the production of potentially hazardous dyes or pigments so as to prevent global warming. As a result, the interest in the use of natural dyes in textile colouration revives as natural dyes are biodegradable, non-toxic and eco-friendly, and that they do not cause health problems, environmental pollution and waste water problem [4-7]. The pigments which have potential use in textile dyeing industries are produced from plants such as Hibiscus mutabilis rose, Lawsonina Inermis L.,

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Indigofera tinctoria, Rubia tinctorum, Rubia cordifolia, Anchusa tinctoria, Salix negra etc.[8,9]. In the textile dyeing process, it is necessary that the auxiliaries, chemicals and the dyes used to dye textile materials should be eco-friendly in nature, and the dyeing methods adopted should lead to conservation of water, energy, and chemicals.

The textile industries have been researching for new and alternative technologies to meet both the quality and eco-friendly production [10]. Plasma technology, using ultrasonic and microwave energy, enzymatic process are the new and alternative technologies used in the textile industry. Plasma technology, innovatively applied to textile material as a pre-treatment, causes a variety of surface modifications of textile materials. It also improves a wide range of textile properties such as hydrophobicity, dye exhaustion, and adhesion [11]. In addition, plasma technology, as a clean, ecologic and dry technique, is characterized by low consumption of water, energy and chemicals [12-14]. Ultrasonic energy results in occurrence of the dyeing process at low temperatures, which, in turn, optimizes the use of heat energy. However, the materials dyed via conventional method gave better results than those dyed via ultrasonic method in terms of the fastness and colour retention [15,16]. Another technology for conserving energy is microwave technique using in the textile wet process. In this process, microwave energy is used to heat the liquor and microwave radiation provides more uniform heating in the liquor as opposed to the heating via conventional method. Whilst the outer wall heats up first in conventional method, the center of the liquor heats up first in microwave method. Subsequently, each point of solvent equally warms up. As such, the temperature of the liquor increases faster compared to conventional method. Thus, as an alternative method, microwave energy decreases energy consumption, and saves time in comparison with the conventional method [17-19].

In this study, silk fabric was dyed with the natural dye extracted from blueberry via ultrasonic, microwave, and conventional methods. One of the samples dyed via conventional method was also treated oxygen plasma application whereas the other was mordanted with aluminium potassium sulphate prior to the dyeing process. Then the colour and fastness properties were investigated with regard to dyeing process.

2. Material And Methods

2.1. Materials

In this study, plain weaved silk fabric with the weight of 80 g/m^2 was dyed with the natural dye which is of anthocyanins chemical structure (Figure 1) extracted from *Vaccinium Corymbosum*. The compounds of anthocyanins are given in the Table 1.

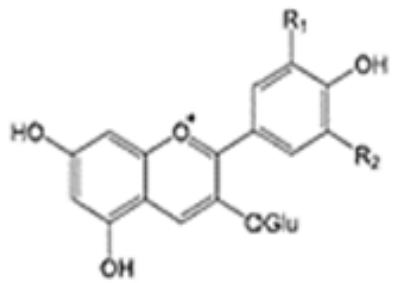


Figure 1. *Chemical structure of anthocyanins [20]*

Blueberry fruits were picked from the region of Black Sea. After, the fruits were cleaned and 1000 grams fruit and 20 l soft water were blended. This blend was boiled for an hour. Lastly, after the blend was refrigerated, the blend was filtered and the dyes fluid was extracted.

Table 1. *The compounds of anthocyanins [20]*

Compound name	Substituents		Ingredients (%)
	R_1	R_2	
Meleidin-3-glucoside	OMe	OMe	49
Peonidin-3- glucoside	OMe	H	20
Petunidin-3- glucoside	OMe	OH	15
Delphinidin-3- glucoside	OH	OH	13
Cyanidin-3- glucoside	OH	H	3

2.2. Plasma Treatment

The plasma treatment of silk fabric was carried out with oxygen gas in Diener vacuum plasma. The sample was placed onto the anode with the pressure of the chamber at 0.3 mbar and the plasma treatment was performed with low frequency, at 40 kHz, at a power of 100 W, for 5 minutes.

2.3. The Mordanting Process

The mordant solution was prepared by 10 grams of aluminium potassium sulphate was dissolved in 1000 ml distilled water. Then the fabrics were treated at the liquor ratio of 1:50 with this solution for one hour at the boiling temperature about 98o C.

2.4. Dyeing Process

In this study, the samples were dyed with the blueberry extracts via conventional, ultrasonic and microwave dyeing method at the liquor ratio of 1: 50. In conventional method, the samples were dyed at the boiling temperature for an hour. In ultrasonic method, the dyeing process was carried out with Maxwell Ultrasound Dyeing device at 70 ºC for 15 minutes and the samples were exposed to 20 kHz ultrasonic power. After many pre-treatments were performed in the ultrasonic device the optimum dyeing conditions were determined. Microwave energy method was applied by using Kenwood MW 467 Model Oven at the frequency of 2.45 GHz. The microwave oven had a maximum power of 800 W with six discrete settings. The fabric specimens were immersed to cooled dyestuff solution, and were dyed in microwave oven at the middle-high level for 3 minutes. After the all dyeing process, the samples were firstly rinsed with cold water, secondly with hot water, and finally with cold water. The properties of dyeing process and samples code were given in the Table 2.

2.5. Fastness Properties

The washing fastness of samples was tested by using Gyrowash/James H.HealCo.Ltd test instrument according to ISO105:C06 [24]. Then the results were evaluated with the gray scale. The light fastness of samples was analyzed by using Atlas Alfa 150 S test instrument according to EN ISO 105 – B02. The rubbing fastness of samples was determined by using James H. Heal 255 crock meter according to ISO 105 X12 [21-23].

Table 2. *The properties of dyeing process*

Sample Code	Dyeing Properties
Conventional without Mordant	The conventional dyeing without mordant
Conventional with Mordant	The conventional dyeing with mordant
Ultrasonic	The dyeing with ultrasonic energy
Microwave	The dyeing with microwave energy
Plasma Pre-treatment	The conventional dyeing after the plasma pre-treatment

2.6. Colour Measurements

The reflectance values of the dyed fabrics were measured by using Gretaq Macbeth – Colour Eye 2180UV spectrophotometer and the CIELab values were calculated using illuminant D65 and 10o standard observer values. The colour strength (K/S) values of samples were calculated with the Kubelka-Munk equation24 and the reflectance values (R) at the maximum absorption wavelength (λmax). The calculation of K/S values was achieved in accordance with the maximum absorption in 520 nm.

2.7. Analysis of Surface

The surface of samples was analyzed with scanning electron microscope (SEM) by using ZEISS/EVO 40 electron microscope. Furthermore, the chemical groups of samples were analyzed with PERKIN ELMER Spectrum 100 ATR-FTIR Model Spectrophotometers.

3. RESULTS AND DISCUSSION

3.1. Colour Measurements

The samples were categorized into five groups. The first group of samples dyed with the blueberry extracts without mordant via conventional method was accepted as standard for colour measurement. The second group of samples dyed with blueberry extracts after the mordant process. The third group of samples treated with oxygen plasma treatment was dyed with the blueberry extracts via conventional method. The fourth and fifth group of samples were dyed with the blueberry extracts via ultrasonic and microwave method, respectively. CIELab values and colour differences of dyed samples are given in Table 3. The samples dyed with blueberry extracts without mordant was accepted as standard for colour measurements.

The results indicated that the ΔL* values of samples were lighter than the standard sample. The closest value to the standard sample as the lightness-darkness (ΔL*) value was obtained with the sample dyed via microwave method. Furthermore, green nuance was dominant in all of the samples. The least green nuance was observed in the sample dyed after the plasma treatment. In the blue-yellow axis, the closest value to the standard sample was obtained with the sample dyed via conventional method with mordant. In addition to this result, the other samples were bluer than the sample dyed via conventional method with mordant. Moreover, the results indicated that the colour differences of all the samples were inadmissible (ΔE* > 1). Here, the greatest ΔE* value was obtained with the sample dyed after the plasma treatment whereas the lowest value was obtained dyed via conventional method with mordant. Finally, the investigation of the chroma values of samples demonstrated that the chroma value of the sample dyed via microwave method was higher than those of the other samples.

The results of colour strength (K/S) values of the samples dyed via different methods are given in Figure 2.

Table 3. *CIELab values of dyed samples*

Method	L*	a*	b*	C*	h°	X	Y	Z
Conventional with Mordant	45.37	7.15	1.80	7.37	14.16	15.21	14.81	15.09
Ultrasonic	46.48	8.44	-2.30	8.75	344.77	16.25	15.63	17.87
Microwave	43.99	8.72	-4.58	9.85	332.31	14.48	13.83	16.90
Plasma Pre-treatment	51.27	9.14	-0.52	9.16	356.72	20.29	19.50	21.21

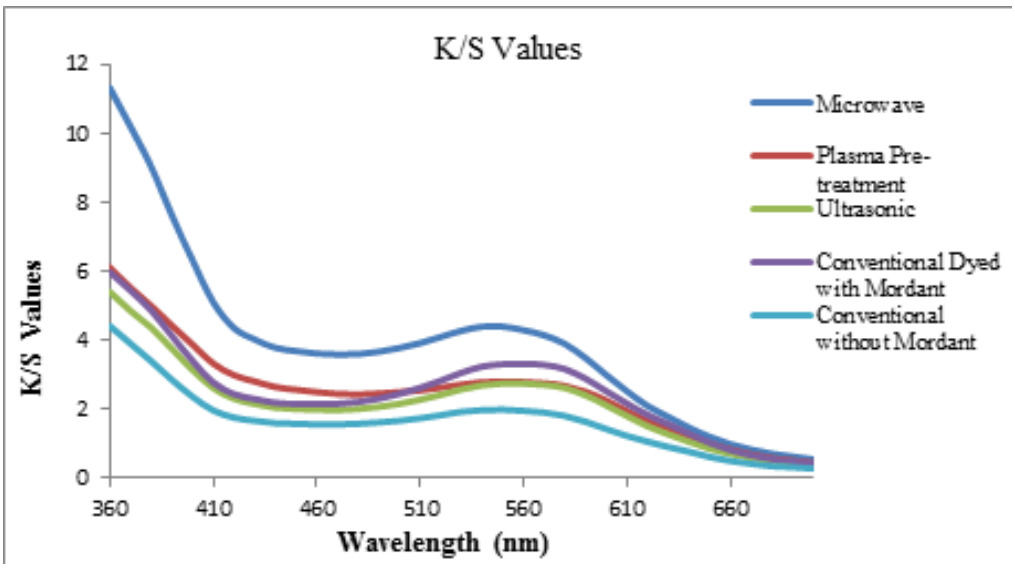


Figure 2. *The K/S values of the dyed silk samples*

According to the colour strength results (K/S) of samples dyed via different methods, the sample dyed via microwave method was slightly better than the other samples dyed via different methods in a short time of dyeing.

Furthermore, the SEM images indicated that no damages to the samples dyed via ultrasonic, microwave, and conventional method were observed. Microwave heating is characterized as the volumetric heating in which heat diffuses around the instrument from the surface of the material. In volumetric heating, the materials can directly and internally absorb microwave energy and convert it into heat, providing rapid, controlled, selective, and uniform heating. Moreover, microwave heating results in increasing the diffusion of organic molecules into polymers, which in turn increase the fixing rate of dyes into the polymeric textiles [25]. The results demonstrated that the volumetric heating is more effective the plasma treatment, mordant and ultrasonic energy. Ultrasonic power, used in ultrasonic method, diffuses like sound waves in liquid, which results in stretching and relaxation in the structure of liquid. The application of negative pressure on liquid causes fission of liquid and cavitation bubbles. Under pressure, collusion of these bubbles with each other results in diffusion of a great amount of energy, which in turn were used in the textile wet process [25,26]. Compared to the ultrasonic and conventional process, the ultrasonic energy accelerates the chemical and physical reactions in the dyeing process [27,28]. For these reasons, the duration of the dyeing process is short and uniform.

3.2. Results of Fastness

The fastness properties of dyed samples are given in Table 4.

As shown in Table 3, the values of colour change with respect to the reference samples of silk materials were quite low. In this regards, it was illustrated that these processes did not have much effect on the colour change in terms of washing fastness.

According to the washing fastness results, it was observed that there were not much differences among the staining values in terms of conventional, ultrasonic, and microwave method, and

Table 4. *The fastness properties of dyed fabrics*

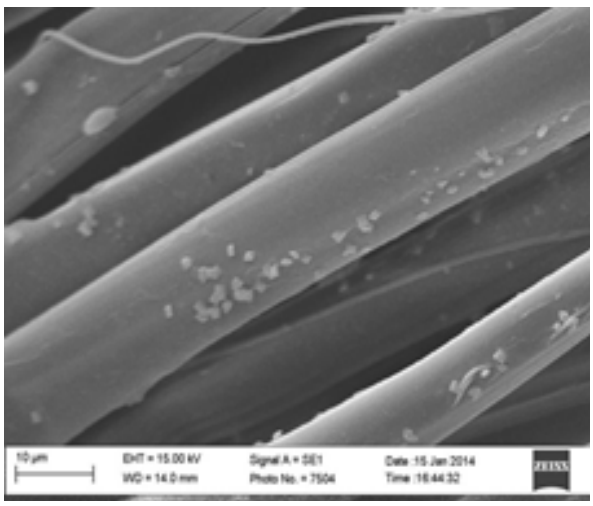
	Light fastness	Washing fastness							Rubbing fastness	
		Colour change	Staining						Dry	Wet
Dyeing method			CA	CO	PA	PES	PAN	WO		
Conventional dyeing without mordant	1	1	4-5	4-5	3-4	4-5	5	5	5	5
Conventional dyeing with mordant	2	1	4-5	4-5	3-4	4-5	5	5	5	5
Ultrasonic dyeing	2	1-2	5	5	5	5	5	5	5	5
Microwave dyeing	1/2	1	5	1-2	4	5	5	5	5	5
Plasma pre-treatment	2	1	5	5	5	5	5	5	5	5

applying plasma pre-treatment. In addition, according to the rubbing results, these methods does not effect on the rubbing fastness.

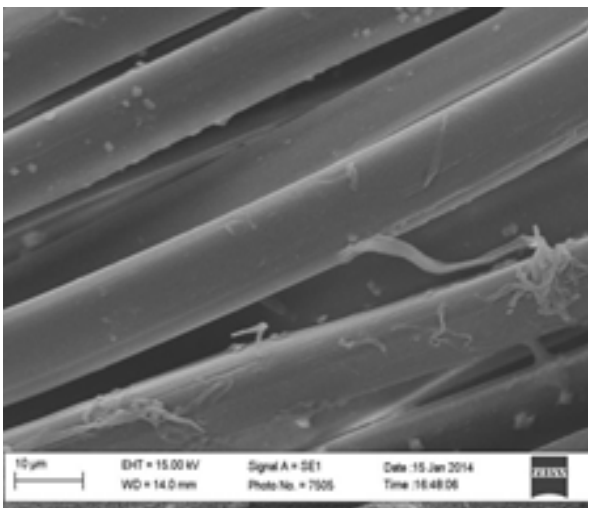
Furthermore, the dyeing methods do not effect on the light fastness properties of samples. The light fastness of all samples is low. The reason of this result is deemed that the chemical structure of natural dyes damaged very quickly with light.

3.3. Characterization of the Surfaces of Dyed Samples

The surfaces of silk samples are characterized with SEM and the SEM images are given in Figure 3.



(a)



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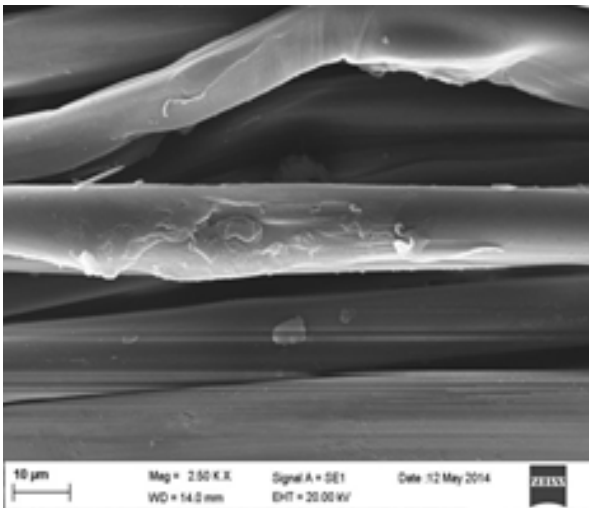

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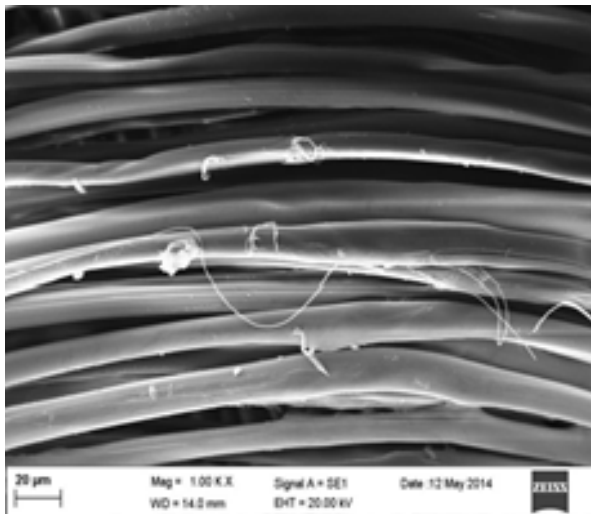
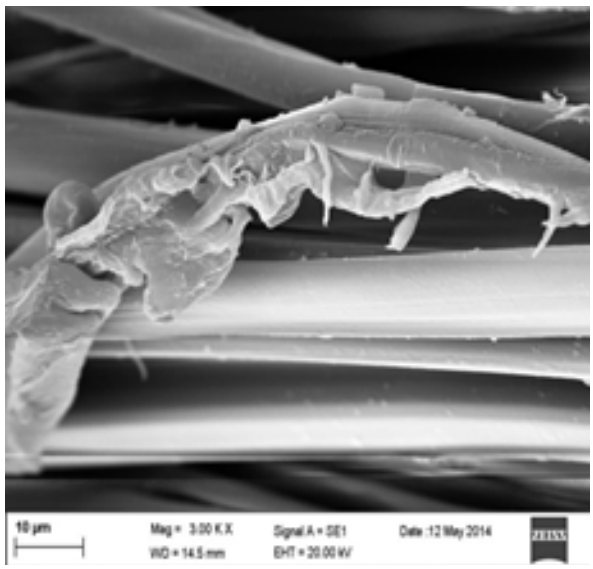


(d)



(e)

Figure 3. *SEM images for silk fabrics ((a) conventional dyeing without mordant; (b) conventional dyeing with mordant; (c) ultrasonic dyeing; (d) microwave dyeing; (e) plasma pre-treatment)*

From the SEM results, one can conclude that oxygen plasma treatment caused deformation on the surface of silk fibers (Figure 3e). Considerable deformation was not observed on the surfaces of samples dyed via conventional, microwave, and ultrasonic methods. It was deemed that the deformation of the plasma treatment increased in the capillarity of plasma treated sample.

3.4. Fourier Transform Infrared Spectroscopy Spectra Dyed Samples

The results of FT-IR ATR spectra of samples are given in Figure 4.

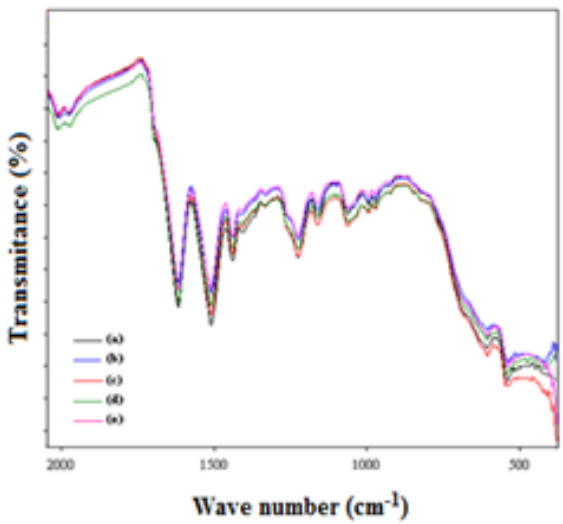


Figure 4. *FT-IR ATR spectra: (a) conventional dyeing without mordant; (b) silk fabric with plasma treatment; (c) conventional method with mordant; (d) microwave method; (e) ultrasonic method*

FTIR-ATR values of samples dyed with blueberry extract via different dyeing methods were given in Figure 4. As seen in FT-IR ATR spectra, the existence of the groups of Amide I (1655 cm $^{-1}$ – 1630 cm $^{-1}$) and Amide II (1530 cm $^{-1}$ – 1575 cm^{-1}) demonstrated that silk fabrics are of the structure of β molecular [29-31]. According to FTIR-ATR graphic, the bonds between C-C, C-N, C-H, and N-H stress were shown ranged from 1466.78 cm $^{-1}$ to 1399.69 cm $^{-1}$, 1260.30 cm $^{-1}$,1580.40 cm^{-1} and, 1635.63 cm $^{-1}$, respectively. Furthermore, according to the results, plasma pretreatment, microwave and ultrasonic energy did not affect the chemical bonds of silk fabric.

4. Conclusions

In this study, natural textile materials such as silk fabric were dyed with natural dye extracted from blueberry via different dyeing methods. According to the results, the colour of the sample dyed with microwave energy was darker than those of other samples. The values of colour differences of silk fabrics were not accepted. Besides, the dyeing methods did not affect the improvement of the light fastness of samples. Likewise, it was demonstrated that the processes are not much effective on the washing and rubbing fastness of dyeing. In conclusion, it should be specified that plasma pre-treatment, ultrasonic and microwave methods provide an eco-friendly dyeing process for the silk materials dyed with the natural dyes extracted from blueberry. Moreover, according to the results, as opposed to conventional method, dyeing via ultrasonic and microwave methods were conducted in shorter periods of time and energy.

Besides, according to the results of the SEM analysis, ultrasonic and microwave dyeing method did not harm silk fibers as opposed to plasma pre-treatment. Further, FT-IR analysis indicated that plasma pre-treatment, ultrasonic, and microwave energy did not change the chemical bonds of silk fabrics.

REFERENCES

[1] Bulut M.O., Akar E. Ecological dye ing with some plant puls on woollen yarn and cationized cotton fabric, Journal of Cleaner Production 2012; 32; 1-9.

[2] Angelini L.G., Bertoli A., Rolandelli S., Pistelli L. Agronomic potential of Reseda luteola L. as new crop for nat ural dyes in textiles production, Indus trial Crops and Products 2003; 17; 199-207.

[3] Ibrahim N.A., El-Gamal G.M., Mahrousa F. A new approach for nat ural dyeing and functional finishing of cotton cellulose, Carbohydrate Polymers 2010; 82; 1205–1211.

[4] Bechtold T., Amalid M.A., Mussak R. Natural dyes in modern textile dye houses — How to combine experi ences of two centuries to meet the demands of the future?, Dyes and Pig ments 2007; 75; 287-293.

[5] Haar S, Schrader E, Gatewood B.M. Comparison of aluminum mordants on the colorfastness of natural dyes on cotton, Clothing and Textiles Research Journal 2013; 31(2); 97-108.

[6] Barka N, Assabbane A, Nounah A, Laanab L, Ichou Y.L. Removal textile dyes from aqueous solution by natural phosphate as new adsorbent, Desalination 2009; 235; 264–275.

[7] Baliarsingh S, Panda A.K, Jena J, Das T, Das N.B. Exploring sustainable technique on natural dye extraction from native plants for textile: identifi cation of colourants, colourimetric analysis of dyed yarns and their anti microbial evaluation, Journal of Cleaner Production 2012; 37; 257-264.

[8] Shanker R, Vankar P.S. Dyeing cotton, wool and silk with< i> Hibiscus muta bilis</i>(Gulzuba), Dyes and Pig ments 2007; 74; 464-469.

[9] Kale K.H, Palaskar S. Atmospheric pressure plasma polymerisation of hexamethyldisiloxane for imparting water repellency to cotton fabric, Tex tile Research Journal 2011; 81(6); 608–620.

[10] Verschuren, J., Herzele, P.V., Clerck, K.D., Kıekens, P. Influence of fiber surface purity on wicking properties of needle-punched nonwoven after ox ygen plasma treatment, Textile Re search Journal 2005; 75(5); 437–441.

[11] Sahahidi S, Rashidi A, Ghoranneviss M, Anvari A. Wiener, J. Influence of plasma sputtering treatment on natu ral dyeing and antibacterial activity of wool fabrics, Surface&Coatings Technology 2010; 205; 349-354.

[12] Omerogulları Z, Kut D. Application of low-frequency oxygen plasma treat ment to polyester fabric to reduce the amount of flame retardant agent, Tex tile Research Journal 2012; 82(6); 613–621.

[13] Bhat N.V, Netravali A.N, Gore A.V, Sathianarayanan M.P, Arolkar G.A, Deshmukh R.R. Surface modifi cation of cotton fabrics using plasma Technology, Textile Research Journal

2011; 81(10); 1014–1026.

[14] Mason T.J, Lormier J.P. Uses of ul trasonic chemistry, Ellis Horwood Limited; 1988.

[15] Khatri Z, Memonb M.H, Khatri A, Tanwari A. Cold Pad-Batch dyeing method for cotton fabric dyeing with reactive dyes using ultrasonic energy, Ultrasonics Sonochemistry 2011; 18; 1301–1307.

[16] Büyükakıncı, B.Y, Usage of Micro wave Energy in Turkish Textile Pro duction Sector, Energy Procedia 2012; 14; 424 – 431.

[17] Ahmed N. S. E, El-Shishtawy R.M.E. The use of new technologies in col oration of textiles fibers, Journal of Materials Science 2010; 45(5); 1143-1153.

[18] Wang S.Y, Chen C.T. Effect of allyl isothiocyanate on antioxidant enzyme activities, flavonoids and post-harvest fruit quality of blueberries (Vaccinium corymbosum L., cv. Duke), Food Chemistry 2010; 122; 1153–1158.

[19] Punrattanasin N, Nakpathom M, Som boon B, Narumol N, Rungruangkitkrai N, Mongkholrattanasit R. Silk fabric dyeing with natural dye from man grove bark (Rhizophora apiculata Blume) extract Ind.Crops and Prod ucts 2013; 49; 122-129.

[20] Lin Y. H, Saotome A, Kohno Y, Shiba ta M. Antrahocyanidin dye and Al/ Fe-containing mesoporous silica com posites and their color properties, Journal of the Japan Society of Colour Material 2013; 86(11); 397-402.

[21] ISO 105-C06 Standard. Textiles-Tests for Colour Fastness- Part C06: Colour Fastness to Domestic and Commercial Laundering, (2010).

[22] EN ISO 105 – B02 Standard. Tex tiles-Tests for Colour Fastness- Part B02: Colour Fastness to Artificial Light: Xenon Acr Fading Lamp Test, (1994).

[23] ISO 105 X12 Standard. Textiles-Tests for Colour Fastness- Part X12: Colour Fastness to Rubbing, (2001).

[24] Oner E, Büyükakıncı Y, Sökmen N. Microwave-assisted dyeing of poly(butylene terephthalate) fabrics with disperse dyes, Coloration Tech nology 2013; 129; 125-130.

[25] Duran K ,Bahtiyari M.İ, Körlü A.E, Dereli S. Ultrasonic technology, Tekstil ve Konfeksiyon 2006, 3, 155.

[26] Gogate, P.R. Cavitational reactors for process intensification of chemical processing applications: a critical re view, Chemical Engineering and Pro cessing: Process Intensification 2008; 47 (4); 515-527.

[27] Guesmi A, Ladhari N, Sakli F, Ultra sonic preparation of cationic cotton and its application in ultrasonic natu ral dyeing, Ultrasonics Sonochemistry 2013; 20; 571–579.

[28] Akalin M, Merdan N, Kocak D, Usta I. Effects of ultrasonic energy on the

wash fastness of reactive dyes, Ultra sonics 2004; 42; 1–9.

[29] Arai T, Freddi G., Innocenti R, Tsuka da M. Biodegradation of Bombyx mori silk fibroin fibers and films, Jour nal of Applied Polymer Science 2004; 91 (4); 2383–2390.

[30] Shao, J., Zheng, J., Liu, J., Carr, C.M. Fourier transform Raman and Fouri er transform infrared spectroscopy studies of silk fibroin, Journal of Ap plied Polymer Science 2005; 96 (6); 1999-2004.

[31] Mathur A.B, Tonelli A, Rathke T, Hudson S. The dissolution and char acterization of Bombyx mori silk fi broin in calcium nitrate-methanol solution and the regeneration of films, Biopolymers 1997; 42 (1); 61–74.

Evaluation Of Street Furniture According To Basic Design Principles

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Abstract
In the urban context, it is important to create more comfortable and livable environments with proper planning, design and application. Because aesthetic considerations are of more importance today, designing urban furniture to give a more beautiful appearance to cities is of high priority; designers and those working in related disciplines must be careful to observe these principles throughout the design process. This paper describes research conducted to review the aesthetic principles involved and how they relate to urban furniture.

Keywords: *Urban Environment, Street Furniture, Aesthetic, Basic Design, Principles of Arrangement.*

1. Introduction

In urban design, arrangements of elements that create visual coherence produce eye-catching and memorable images. As elements complementing the image of a city, urban furnishings play an active role in urban design as a whole, whether for their functional or aesthetic values [1]. Integrating urban furniture with the architectural characteristics of a space is important in terms of its acceptability and likeability to the people who use it. When harmoniously designed and put together, seating units, trash cans, signboards, lighting units and similar furnishings have a positive visual effect on urban space; well designed urban furniture that reflects or complements a city can become symbolic of the city over time. Examples of this are the red telephone booths of London and the lighting elements on the Notre Dame Bridge in Paris (Figure 1) [2; 3].

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Figure 1. *London, England [URL 1]; Paris, France [URL 2]*

In the process of designing and/or selecting urban furniture, architectural, natural and social environments and climate must be evaluated carefully. In particular, the architectural environment in which furnishings are being used can be helpful to the designer in deciding on the details of dimensions, design, color, materials, features, and construction. In addition, for urban furniture to be used effectively, it has to be ergonomic, feature measures to prevent injuries that might be incurred by users, and have periodic maintenance work done on it [4].

2. Design Principles Used For Evaluating Urban Furniture

In man-made spaces, the environment is made up of the elements, forms, textures and colors that are found there. It is important that there is unity between the aesthetic values of the space and the product [2]. Aesthetic perceptions, which vary according to each individual's own life perspective, together with cultural commonality, play a role in shaping the artificial elements that form part of a city's identity [5].

It is important to ensure that the proper relationship is established between items of urban furniture, each taken as a design product, and with the place where they will be located [6]. Things that are effective in giving an identity to an area–such as symbolic aspects, psychological effects, materials, elements of texture and color, accessories, promotional elements, natural balances, and numerous other elements and characteristics that give similar peacefulness and pleasure to people from a psychological and biological perspective–enhance the quality of spaces [7], and at the same time create spaces that are comfortable and aesthetically pleasing [8; 9].

Urban furniture must be designed according to certain standards from the perspective of anthropometric measurements; attention must be paid to functional and aesthetic characteristics (line, measurement, form, color, texture, etc.); and the design must be unique [10; 11]. And it is important that the way urban furniture is to be used is easily understandable [12].

For a successful sustainable perception and usage of spaces, the design elements must be emphasized, and individuals' sense of familiarity, reactions and gut instincts must be thought of as responses [13].

The criteria that affect to what extent urban furniture design makes a difference or how much it is liked by users have been determined as follows: color harmony, dimensional/proportional balance, functional suitability, suitability of materials; being maintained/clean, modern, new; having historical qualities, referring to history; being different, attractive, interesting, striking, original/unique; in a good location, in keeping with the surroundings or clashing with them; being

meaningful and monumental, being symbolic, creating visual richness [14].

Form, color and texture, as well as materials and functionality are thought to be effective in urban furniture design. Each of the item have own characteristics while designing in urban areas.

2.1. Form

The form determines the function, dimensions and material. The form of an object derives from the functions related to it and what service it is expected to provide (Figure 2). It is important that the way urban furniture is used is easily understood. The criteria for the duration of perception and perception itself include a sense of security as another effective factor [12].

Figure 2. *Hamburg, Germany [URL 4]*

Form also plays an important role in determining the character of a place. The character of a place or the felt sense of identity is produced by the characteristics of form, materials, texture and color, and also the cultural mixtures created by people over time. For example, if we think about lighting elements, we see differences in the forms of lighting and the way they are used in different spaces in a city. Different kinds of lighting are used to illuminate roads for vehicles, pedestrian paths, squares, parks, gardens and green areas [13]. There will be different formal characteristics in the lighting elements that provide these kinds of illumination (Figure 3). To take another example, if we consider the forms of seating elements, we see that these forms affect how they are used. Seating elements for two or three people (Figure 4, left) provide alternatives for people who want to sit alone, while seating areas designed with curvilinear forms (Figure 4, right) encourage people to engage in conversation more and be social.

Figure 3. *London, England [URL 5]; Budapest, Hungary [URL 6]*

2.2. Color

Color, which serves aesthetic purposes and is also part of the system of perception, determines the quality of a space, adds a separate depth and dimension to the arrangement of urban spaces by foregrounding the materials, design elements and furnishings that are used [23].

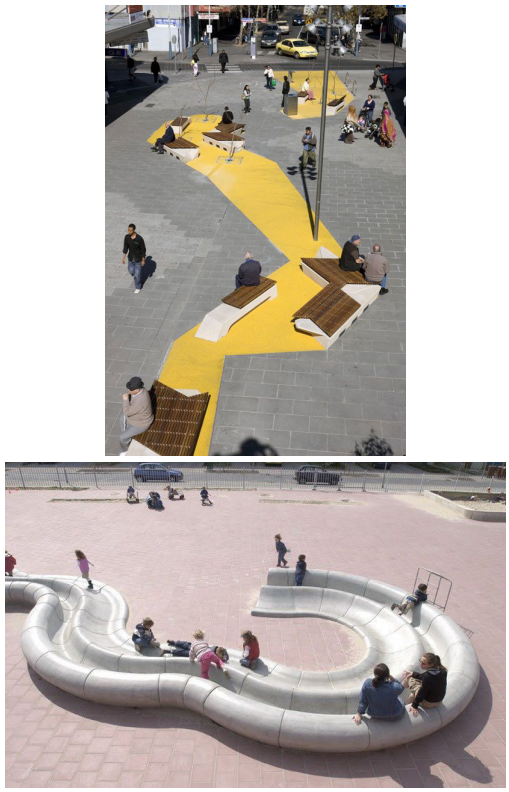

Figure 4. *Victoria, Australia [URL 7]; Bereda, Netherland [URL 8]*

For urban furniture to perform its functions, it must be visible and with suitably chosen colors [24]. Each item of urban furniture should have, in contrast to its environment, strong chromatic and bright colors (Figure 5). In this way, it can easily be recognized and understood by people who use it, especially the visually challenged [25]. For example, trash cans, from their color, should be noticeable from far off. Once trash can colors have started being used, these colors should be kept so that the understanding of them remains the same. Bright colors are appropriate in terms of their visibility, while dark colors and natural colors are more resistant to rust and misuse, but visually are not easily visible [26].

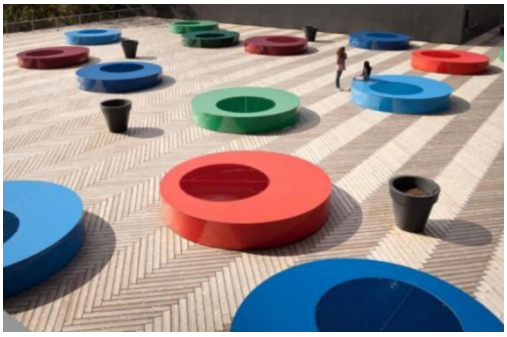

Figure 5. *Vienna, Austria [URL 11]*

2.3. Texture

Texture refers to a surface where at each level similar or repeated elements from lower levels are found. Factors which are effective in the perception of texture are: the strength of the light, its angle of incidence, and the shadow it creates; distance (heavily textured elements are perceived from further away in comparison to lightly textured elements); and material differences. Urban furniture, texture and conceptual forms are closely related to each other. Texture is important in the design for both technical and aesthetic reasons (Figure 6).

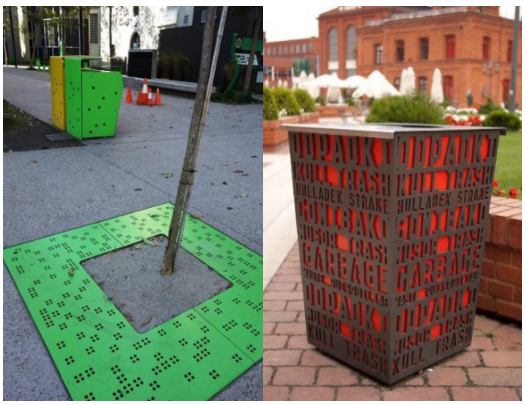

Figure 6. *Warsaw, Poland [URL 12]; Sidney, Australia [URL 13]*

Visually, it creates interesting surfaces and hides small faults [27]. In creating texture, using a variety of materials is of the utmost importance [28]. Besides physical and visual attributes, texture makes a substantial contribution to the structure as well as to the material functionality of the product [29]. It is natural for quite different factors to be taken into consideration in the design of urban furniture. Among these are public aspects such as traditions, preconceptions, and historical texture, psychological aspects such as the resulting perceptions, aspects of meaning conveyed by the characteristics of the materials used, and aesthetic aspects brought in by the dimensions of the design.

2.4. Materials

Urban furniture may show differences and innovations during the design process, as it is affected by the development through technology of a diversity of materials and the currents of fashion. In addition to looking at the function of a product in the design, attention must be paid when selecting materials to the visual effect that one wants to create in the product that is being designed. A diversity of materials enables the creation of different forms, enhances the visual quality of the products, and enriches the design [17]. To ensure that urban furnishings can endure environmental conditions, attention must be paid during the design stage to factors like the correct choice of materials and their placement. In the choice and design of furniture, climatic factors like daylight, expansion and contraction, wind stress, moisture, and at the same time salt, ice or frost, must be taken into account. The best designs use strong, simple shapes and natural materials [18; 19].

With regard to the characteristics of the material used, the stability of the product and the psychological effects it creates are important. Concrete seating units, when compared to wooden ones of the same dimensions, have a massive and heavy look [12]. The reasons for selecting a particular material for urban furniture can be summed up as: appropriateness for its function, fitting in with environmental constraints, and suitability for giving form [20]. Urban furniture in areas with a fire hazard should be made from materials like metal, brick and stone, not from wood, which is potentially flammable [12; 21]. The materials most used in urban furniture are steel and wood; alternatives are stone, concrete, recyclable plastic and glass, etc (Table 1). While each of the materials described above can be used on their own in furniture design, more than one in combination with others can also be used (Figure 7). The choice of materials varies depending on the content and the restrictions on design; important issues, for example, are the furniture's resistance to vandalism, the costs involved, and how frequently it will be used.

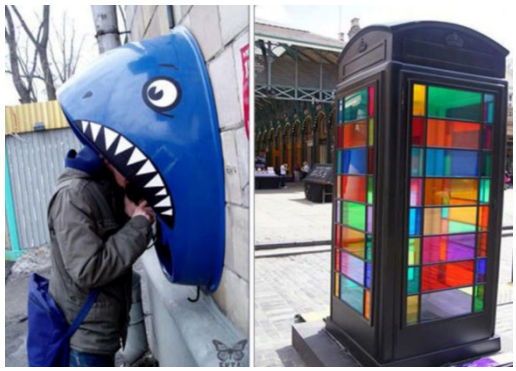

Figure 7. *Denver, United State of America [URL 10]*

2.5. Functionality

It is possible to have spaces which have quality and an identity and give pleasure to people, by placing urban furniture in them which is functional, aesthetic, and economically produced, which suits its purpose and is used properly and habitually [15].

Table 1. *The materials used in urban furniture[22].*

Steel	Because steel is characteristically versatile in its uses, strong and lightweight, and can take any shape desired, it is the most preferred material. It is durable, and resistant to rust and to impact; and requires little maintenance. It is relatively cheap compared to other materials, because it can be reproduced through recycling.
Wood	This is one of the most preferable materials. It is a natural material, which unlike other materials, feels hot when the weather is cold, and cold when the weather is hot. Its disadvantage is that unlike metallic materials, it takes longer to dry after rain, and needs more maintenance. It has low resistance to vandalism.
Concrete	Because concrete materials are heavy, there may be no need to install them. They are resistant to vandalism, apart from spray-paint. Concrete is a durable and aesthetically attractive material.
Stone	Stone, like concrete, is durable and resistant to vandalism. It is difficult to dry after rain, and when aesthetic concerns are considered, it offers only limited design possibilities.
Plastic	Recyclable materials are generally made of plastic, which presents a smooth surface and appearance. Compared to wooden materials, it is more durable, needs less maintenance, and is cheaper in the long term.

For urban furniture to be identified as functional, the most important factor is that it should be in keeping with human ergonomics [12]. In its design, forms should be chosen with regard to their function, to suit their purposes. If a unique urban furniture design does not convey this functionality, then it can cause problems in the space where it is located (Figure 8).

Figure 8. *Vancouver, Canada [URL 3]*

In urban public spaces, to meet people's needs, collectively used furnishings that have more than one function are used in diverse ways. We can categorize urban furniture items in terms of their functions as follows: for protection, e.g. traffic lights to control the flow of traffic, traffic signs, lighting elements; for resting, e.g. seating elements; for cleaning, e.g. trash cans; for pleasure, e.g. urban furniture for recreation and children's games; for sales and shopping, e.g. snack bars, ticket offices, automatic sales machines; for communication, e.g. telephone booths; for accommodation, e.g. shady spots, awnings, bus stops; for guidance, e.g. flooring overlay elements, street signs, underpasses and overpasses; for restricting, e.g. fences, railings, walls, flowerbeds, protective materials for tree roots; for providing information, e.g. notice and advertising boards, clock towers in squares; and for decoration, e.g. flower planters, sculptures and waterworks.

3. Field Work/Research

This study examined the factors that are thought to be effective in urban furniture design, including elements of form, color and texture, as well as materials and functionality. In addition, the effects of these concepts on people was measured by means of a questionnaire study.

3.1. Research Methods

With the results of the research, a questionnaire study was conducted in order to evaluate the aesthetic criteria for urban furniture. The targeted information was divided into two

groups in the questionnaire form. In the first group, the aim was to determine the objective variables of the subjects, such as the gender, age, marital status, income, educational status, and occupation of the participants. In the second group, individuals' principles and psychological perceptions of unity, harmony, interestingness, simplicity and complexity, emphasis, balance, and rhythm were studied; and the relationships between their aesthetic preferences and principles were researched. In order to set up a relationship between urban furniture and aesthetic perceptions, and with the preconceived idea that an aesthetic is more perceptible to educated people, a sample of 200 people from high schools and universities was used as a subject group for the questionnaire study.

3.2. Research Hypotheses

In light of the theoretical information mentioned in the previous sections, 11 hypotheses were identified to evaluate urban furniture in terms of aesthetical organizational principles; the correctness of these hypotheses was studied according to the participants' gender differences, as determined in the questionnaires.

H1: People would find unity in design, more aesthetically pleasing than interestingness and harmony.

H2: People would find simple designs more aesthetically pleasing than complex designs
.

H3: The presence of elements like sculptures or fountains would increase the frequency of use of a space.

H4: People would find well-balanced designs more aesthetically pleasing.

H5: People would find rhythmic designs more aesthetically pleasing.

H6: It was thought that people would greatly prefer designs which were at the same time functional and aesthetic to those that were only either functional or aesthetic.

H7: People would find urban furniture more aesthetically pleasing in geometric forms than in natural forms.

H8: People would find urban furniture more aesthetically pleasing in wood than in concrete or metal.

H9: People would find urban furniture more aesthetically pleasing in its natural colors than if it was painted.

H10: People would find urban furniture more aesthetically pleasing if it were fine textures-surfaces than if it had a course surfaces.

H11: People would find urban furniture more aesthetically pleasing if it had smooth surfaces than if it had rough surfaces.

3.3. Method of Analysis

Once the questionnaires were filled out, the data was coded according to the answers received from each subject. Using the Excel (PC) statistical analysis program, the data were analyzed using the relevant basic statistical processes, the relationships between the data were also analyzed; and with the information obtained from the questionnaires, they were subjected to a chi-squared significance test.

3.4. Research Findings

At this stage, first of all, the socio-demographic characteristics of the users of sample spaces were determined. Later, the

results were studied to determine whether or not meaningful relationships could be found between the survey participants' aesthetic understanding and their perceptions of urban furniture. From the participants' responses, their socio-demographic characteristics were determined as shown below (Table 2).

The survey participants' gender distribution was 52.5% male and 47.5% female. Their age distribution was as follows: 52% in the 18-25 age group, 26% in the 26-30 age group, 4% in the 31-35 age group, 2% in the 36-40 age group, 16% in the 41-60 age group. Of the participants, 20% were married and 80% single. In terms of income, 14% were earning minimum wage; 16% a monthly income of 850-2000TL; 18% a salary of 2000-4000TL; 6% more than 4000TL; and 46% had no income. In terms of educational level, 16% identified themselves as high school graduates, and 84% as university graduates. As for occupation 12% of the participants were unemployed, 10% laborers, 6% civil servants, 40% students, 22% employed in the private sector, and 10% self-employed or freelance.

Table 2. *Socio-demographic Distribution*

	Number of Individuals	**Frequency Distribution (%)**
Gender		
Male	105	52.50
Female	95	47.50
Age Group		
18-25	104	52
26-30	52	26
31-35	8	4
36-40	4	2
40-60	32	16
Marital Status		
Single	160	80
Married	40	20
Monthly Income		
None	92	46
850TL (minimum wage)	28	14
850 TL – 2000 TL	32	16
2000 TL – 4000 TL	36	18
above 4000 TL	12	6
Educational Level		
University	168	84
High School	32	16
Occupation		
Not working (Unemployed)	24	12
Student	80	40
Private sector	44	22
Self-employed/ freelance	20	10
Laborer	20	10
Civil servant	12	6

Table 3. *Results of the chi-squared analysis for participants' perceptions of aesthetic, unity, harmony and interest*

	Aesthetic			
SEX	Unity	Interest	Harmony	Grand Total
Men	69	30	6	105
Women	41	36	18	95
Grand Total	**110**	**66**	**24**	**200**
Aesthetic	Unity	Interest	Harmony	Grand Total
Men	57.75	34.65	12.6	105
Women	52.25	31.35	11.4	95
Grand Total	110	66	24	200
			P-Value	0.001356468*

**P- Value < 0.05 is statistically highly significant.*

According to the chi-squared significance test, a majority of participants found unity in design aesthetically pleasing (Table 3). Secondly, participants found interestingness; and third, harmony, aesthetically pleasing. On this basis, Hypothesis 'H1- People would find unity in design, more aesthetically pleasing than interestingness and harmony' was confirmed.

According to the chi-squared significance test, a majority of participants found complex concepts aesthetically pleasing (Table 4). On this basis, Hypothesis 'H2- People would find simple designs more aesthetically pleasing than complex designs' was ruled out.

According to the chi-squared significance test, a majority of participants indicated that the frequency of use of a space would increase with the presence of elements like sculptures or fountains (Table 5). On this basis, Hypothesis 'H3- The presence of elements like sculptures or fountains would increase the frequency of use of a space' was confirmed.

Table 4. *Results of the chi-squared analysis for participants' perceptions of aesthetic, simplicity, and complexity*

	Aesthetic		
SEX	Minimal	Complicated	Grand Total
Men	38	67	105
Women	59	36	95
Grand Total	**97**	**103**	**200**
Aesthetic	Minimal	Complicated	Grand Total
Men	50.925	54.075	105
Women	46.075	48.925	95
Grand Total	97	103	200
		P-Value	0.000250285*

**P- Value < 0.05 is statistically highly significant.*

Table 5. *Results of the chi-squared analysis for participants' perceptions of accentuated elements*

SEX	Aesthetic Yes	No	Grand Total
Men	73	32	105
Women	84	11	95
Grand Total	**157**	**43**	**200**
	Yes	No	Grand Total
Men	82.425	22.575	105
Women	74.575	20.425	95
Grand Total	157	43	200
		P-Value	0.001160061*

**P- Value < 0.05 is statistically highly significant.*

Table 6. *Results of the chi-squared analysis for participants' perceptions of aesthetic and balanced or unbalanced elements*

SEX	Aesthetic Balance	Unbalance	Grand Total
Men	80	25	105
Women	51	44	95
Grand Total	**131**	**69**	**200**
	Balance	Unbalance	Grand Total
Men	68.775	36.225	105
Women	62.225	32.775	95
Grand Total	131	69	200
		P-Value	0.00082698*

**P- Value < 0.05 is statistically highly significant.*

According to the chi-squared significance test, a majority of participants indicated that they found balanced designs more aesthetically pleasing (Table 6). On this basis, Hypothesis 'H4- People would find well-balanced designs more aesthetically pleasing' was confirmed.

According to the chi-squared significance test, a majority of participants indicated that they found rhythmic designs more aesthetically pleasing (Table 7). On this basis, Hypothesis 'H5- People would find rhythmic designs more aesthetically pleasing' was confirmed.

Table 7. *Results of the chi-squared analysis for participants' perceptions of aesthetic and rhythmic or non-rhythmic elements*

SEX	Aesthetic Rhythm	Without Rhythm	Grand Total
Men	52	53	105
Women	27	68	95
Grand Total	**79**	**121**	**200**
	Rhythm	Without Rhythm	Grand Total
Men	41.475	63.525	105
Women	37.525	57.475	95
Grand Total	79	121	200
		P-Value	0.002298891*

**P- Value < 0.05 is statistically highly significant.*

Table 8. *Results of the chi-squared analysis for participants' perceptions of aesthetics and functionality*

SEX	Aesthetic Aesthetic	Function And Aesthetic	Function	Grand Total
Men	8	63	34	105
Women	25	34	36	95
Grand Total	**33**	**97**	**70**	**200**
	Aesthetic	Function And Aesthetic	Function	Grand Total
Men	17.325	50.925	36.75	105
Women	15.675	46.075	33.25	95
Grand Total	33	97	70	200
			P-Value	0.000200701*

**P- Value < 0.05 is statistically highly significant.*

According to the chi-squared significance test, a majority of participants indicated that they preferred urban furniture that was at the same time functional and aesthetically pleasing (Table 8). On this basis, Hypothesis 'H6- It was thought that people would greatly prefer designs which were at the same time functional and aesthetic to those that were only either functional or aesthetic' was confirmed.

According to the chi-squared significance test, a majority of participants indicated that they found natural forms more aesthetically pleasing (Table 9). Secondly, they found geometric forms; and third, geometric and natural forms together, aesthetically pleasing. On this basis, Hypothesis 'H7- People would find urban furniture more aesthetically pleasing in geometric forms than in natural forms' was confirmed.

According to the chi-squared significance test, a majority of participants indicated that they found wood and mixed materials more aesthetically pleasing (Table 10). On this basis, Hypothesis 'H8- People would find urban furniture more aesthetically pleasing in wood than in concrete or metal' was ruled out.

Table 9. *Results of the chi-squared analysis for participants' perceptions of aesthetics and form*

SEX	Aesthetic Geometric	Geometric and Natural	Natural	Grand Total
Men	59	7	39	105
Women	28	7	60	95
Grand Total	**87**	**14**	**99**	**200**
	Geometric	Geometric and Natural	Natural	Grand Total
Men	45.675	7.35	51.975	105
Women	41.325	6.65	47.025	95
Grand Total	87	14	99	200
			P-Value	0.000542643*

**P- Value < 0.05 is statistically highly significant.*

Table 10. *Results of the chi-squared analysis for participants' perceptions of aesthetics and material*

SEX	Aesthetic Wood and Mix	Wood	Plastic	Mix	Grand Total
Men	69	18	7	11	105
Women	38	37	7	13	95
Grand Total	**107**	**55**	**14**	**24**	**200**
	Wood and Mix	Wood	Plastic	Mix	Grand Total
Men	56.175	28.875	7.35	12.6	105
Women	50.825	26.125	6.65	11.4	95
Grand Total	107	55	14	24	200
				P-Value	0.0016152*

**P- Value < 0.05 is statistically highly significant.*

According to the chi-squared significance test, a majority of participants indicated that they found urban furniture in natural colors more aesthetically pleasing (Table 11). The analysis also showed that secondly, they found painted elements aesthetically pleasing. On this basis, Hypothesis 'H9- People would find urban furniture more aesthetically pleasing in its natural colors than if it was painted' was confirmed.

According to the chi-squared significance test, a majority of participants indicated that they found urban furniture with fine textures more aesthetically pleasing (Table 12). The analysis also showed that secondly, they found course textures; and third, combined textures aesthetically pleasing. On this basis, Hypothesis 'H10- People would find urban furniture more aesthetically pleasing if it were fine textures-surfaces than if it had a course surfaces' was confirmed.

Table 11. *Results of the chi-squared analysis for participants' perceptions of aesthetics and color*

SEX	Aesthetic Colored	Natural	Grand Total
Men	27	78	105
Women	44	51	95
Grand Total	**71**	**129**	**200**
	Colored	Natural	Grand Total
Men	37.275	67.725	105
Women	33.725	61.275	95
Grand Total	71	129	200
		P-Value	0.002361784*

**P- Value < 0.05 is statistically highly significant.*

Table 12. *Results of the chi-squared analysis for participants' perceptions of aesthetics and fine or course texture*

SEX	Aesthetic Fine and Course	Fine	Course	Grand Total
Men	14	51	40	105
Women	21	59	15	95
Grand Total	**35**	**110**	**55**	**200**
	Fine and Course	Fine	Course	Grand Total
Men	18.375	57.75	28.875	105
Women	16.625	52.25	26.125	95
Grand Total	35	110	55	200
			P-Value	0.001598285*

**P- Value < 0.05 is statistically highly significant.*

According to the chi-squared significance test, a majority of participants indicated that they found urban furniture with rough textures more aesthetically pleasing (Table 13). The analysis also showed that secondly, they found smooth textures; and third, both, aesthetically pleasing. On this basis, Hypothesis H11- People would find urban furniture more aesthetically pleasing if it had smooth surfaces than if it had rough surfaces - was confirmed.

4. Conclusions

Throughout history, aesthetic concerns have been the primary concern in designing spaces. A certain beauty is sought in a space, and positive perception of the space increases its comfort, and therefore its habitability. If urban furniture is designed in unity with urban space, this gives it an identity, and therefore a connection to the space. The function of the urban furniture is not just as an object of use, art, or communication. Items of urban furniture are elements designed not only for beautification, but to provide comfort, transportation, relaxation, entertainment, and protection from outside effects. The correct planning, designing, placement and regular maintenance of the urban furniture is important.

Table 13. *Results of the chi-squared analysis for participants' perceptions of aesthetics and rough or smooth texture*

SEX	Aesthetic Rough and Smooth	Rough	Smooth	Grand Total
Men	25	31	49	105
Women	12	14	69	95
Grand Total	**37**	**45**	**118**	**200**
	Rough and Smooth	Rough	Smooth	Grand Total
Men	19.425	23.625	61.95	105
Women	17.575	21.375	56.05	95
Grand Total	37	45	118	200
			P-Value	0.000951755*

**P- Value < 0.05 is statistically highly significant.*

Urban furniture items are important not only because of their functionality, but also as complementary and defining visual elements of urban spaces. While items of urban furniture used especially for visual reasons have positive effects on spaces, those having no aesthetic concerns but only functionality have negative effects on the surroundings. These effects, formed positively or negatively, show up more where urban furniture is used more densely, and are reflected in the urban identity. An urban aesthetic which is affected by unfavorable shaping of the urban space is the result of its not being thought of as a unified whole, or of attempts being made to find solutions to the problems without being aware of the whole. Designers deal with aesthetic elements besides functionality, and with new and creative ideas they make products more desirable. And in the process of furniture design, by adding their personal experiences and creativity, while considering universal principles of form, material, color and texture, they play an important role in increasing the users' psychological comforts and the visible quality of the urban environment.

Our evaluation of the questionnaire study showed that participants found urban furniture more aesthetically pleasing if it had unity, balance, rhythm, and a combination of functionality and aesthetics in its design; and if it had geometric forms, natural colors, fine and smooth surface textures; than if mixed and concrete-metal materials were used. We also found that elements such as sculptures or fountains increased the frequency of use of a space.

In the end, it is aesthetic principles where designers' personal foresight is also operating, that will shape the designs of urban furniture. In environmental design, considerations of form, materials, color and texture may play an active role, depending on the needs of a space and the choices made by the designer. In short, within the aesthetic concept of urban furniture, using effective principles can ensure that while each urban space's visible environmental quality is improved, people's psychological comfort can also be increased.

REFERENCES

[1] Güremen, L., Kent Kimliği ve Estetiği Yönüyle Kentsel Donatı Elemanlarının Amasya Kenti **Özelliğinde** Araştırılması, E-Journal of New World Sciences Academy, Cilt: 6, Sayı: 2, 2011.

[2] Güneş, S., Kent Mobilyası Tasarımında Disiplinler Arası Etkileşim. Planlama/ TMMOB Şehir Plancıları Odası Yayını, Sayı: 33, 2005.

[3] Bulut, Y. ve Atabeyoğlu, Ö., Ordu Kenti Doğal ve Kültürel Kaynak Değerlerinin Kent İmajı Yönünden Değerlendirilmesi, Bilimsel Araştırma Projesi, Atatürk Üniversitesi Rektörlüğü, Erzurum, 2007.

[4] Türkoğlu, G., Vandalizm ve Kent Mobilyası Kamu Mekânları Tasarımı Kent Mobilyaları Sempozyumu I. M. S. Ü Mimarlık Fakültesi Yayınları, 1991.

[5] Özer, S., Aklıbaşında, M. ve Zengin, M., Erzurum Kenti Örneğinde Kullanılan Kuşatma Elemanlarının Kent İmajı Üzerindeki Etkileri. Tekirdağ Ziraat Fakültesi Dergisi, 7(2), 2010.

[6] Bayraktar, N., Tekel, A. ve Ercoşkun, Ö. Y., Ankara Atatürk Bulvarı Üzerinde Yer Alan Kentsel Donatı, 2008.

[7] Suher, H., Ocakçı, M. ve Karabay, H., İstanbul Metropoliten Kent Planlama Sürecinde Kent Kimliği ve Kent İmgesi. İstanbul 2020 Sempozyumu, 1996.

[8] Yıldızcı, A. C., Kent Mobilyaları Kavramı ve İstanbul'daki Kent Mobilyalarının İrdelenmesi, I. Uluslararası Kent Mobilyaları Sempozyumu, Bildiriler Kitabı, İstanbul, 2001.

[9] **Çakır**, H. K. ve **Özenç**, A., Kentsel Dış Mekânlarda Kullanılan Aydınlatama Elemanlarının İrdelenmesi: Edirne Örneği. III. Ulusal Aydınlatma Sempozyumu, Ankara, 2005.

[10] Pekin, U. ve Timur, B., Kentsel Dış Mekânlar ve Donatı Elemanları-Eskişehir Kenti Örneği. 21. Uluslararası Yapı ve Yaşam Kongresi Bildiriler Kitabı, Bursa, 2008.

[11] Akyol, E., Kent Mobilyaları Tasarım ve Kullanım Süreci. *Yüksek Lisans Tezi*, İstanbul Teknik Üniversitesi, 2006.

[12] Hacıhasanoğlu, I., Kent Mobilyaları. İstanbul, Teknografik Matbaacılık, İstanbul, 1991.

[13] Çınar, S., Çetindağ, K., Görsel Algılamada Işık ve Renk Faktörü: Sultanahmet Meydanı ve Çevresi Örneği. İstanbul Üniversitesi Orman Fakültesi Dergisi, Seri A, Cilt 59, Sayı 2, 103-120, 2009.

[14] Aksu, V., Kent Mobilyalarının Yer Aldıkları Mekânlara Etkileri Üzerine-Trabzon Kenti Örneği-Bir Araştırma. *Yüksek Lisans Tezi*, Karadeniz Teknik Üniversitesi, 1998.

[15] Yıldırım, E., İstanbul'da Kent Mobilyalarının Değerlendirilmesi, Sultanahmet Meydanı Örneği, *Yüksek Lisans Tezi,* İ.T.Ü. Fen Bilimleri Enstitüsü, İstanbul, 2011.

[16] Harris, C. W. ve Dines, N. T., **Time-saver standards for landscape architecture: design and construction data,** Second edition, McGraw-Hill publishing company, 1998.

[17] Ertaş, D. G. ve Bayazıt, N., Strüktür ve Malzeme Özelliklerinin Endüstriyel Ürün Tasarımına Etkisi, 2. Ulusal Yapı Malzemesi Kongresi, TMMOB Mimarlar Odası Organizasyonu, İstanbul Teknik Üniversitesi, İstanbul, 2004.

[18] Simonds, J. O., Landscape Architecture: A Manual of Land Planning and Design, McGraw-Hill Professional, 1998.

[19] Gage, M. ve Vanderberg, M., Hard Landscape İn Cocrete, Architectural Press, London, 1975.

[20] Zülfikar, C., Kent Mobilyalarının Kullanım İlişkisi, *Yüksek Lisans Tezi,* İ.T.Ü. Fen Bilimleri Enstitüsü, İstanbul, 1998.

[21] Calkins, M.,The Sustainable Sites Handbook: A Complete Guide to the Principles, Strategies, and Best Practices for Sustainable Landscapes (Wiley Series in Sustainable Design), John Wiley & Sons, 2012.

[22] Site Furnishing, Urban Green Inc., Vancouver, B.C., http://www.urbangreeninc.com/looking-for/site-furnishings/ (accessed January 2015).

[23] Kıran, A., Rengin Psikolojik Etkilerinin İncelenmesi ve Deneysel Psikoloji Yöntemi ile Ülkemiz İçin 18-25 Yaş Üzerinde Renk Tercihlerinin Saptanması. Doktora Tezi, Yıldız Teknik Üniversitesi, 1986.

[24] Gamito, M. and Silva, F. M. Urban Furniture − Colour and Inclusivity, 9th Conference of the International Committee for Design History and Design Studies, 2014.

[25] Barker, P., Barrick, J. ve Wilson, R. **,** Building Sight, a handbook of building and interior design solutions to include the needs of visually impaired people, London: Royal, 1995.

[26] Cartwright, R. M., The Design of Urban Space Manual, The Architectural Press Ltd. London, Halsted Press Division. John Kiley& Sons, New York, 1980.

[27] Ashby, M. ve Johnson, K., Materials and Design. Elsevier But Tamworth Heinemann, London, 2004.

[28] Dascalu, D. M, Landscape Effects of Urban Furniture Textures. Bulletin UASVM Horticulture, Sayı: 68, 2011.

[29] Kın, R. E., Tasarımda Doku Kavramı ve İşlevselliği. Yüksek Lisans Tezi, İstanbul Teknik Üniversitesi, 2007.

PHOTO REFERENCES

Url1< http://lewebpedagogique.com/goossensphilippe1/tag/london/#prettyPhoto[pp_gal]/9/ (Erişim tarihi: 4.2015).

Url2< http://www.barloga.com/collections/france-paris/products/ile-st-louis-paris-france (Erişim tarihi: 4.2015).

Url3< http://www.bustler.net/index.php/article/urban_reef_wins_robson_redux_2014_in_downtown_vancouver_canada/ (Erişim tarihi: 4.2015).

Url4< http://www.flickr.com/photos/tlraum/2166398682/in/faves-copacetic/ (Erişim tarihi: 4.2015).

Url5< https://www.pinterest.com/pin/559431584937189871/ (Erişim tarihi: 4.2015).

Url6< https://www.pinterest.com/pin/347692033704376530/ (Erişim tarihi: 4.2015).

Url7< http://www.landezine.com/index.php/2013/01/nicholson-street-mall-by-hassell/nicholson-st_mall-by-hassell-landscape-architecture-02/ (Erişim tarihi: 4.2015).

Url8< http://www.play-scapes.com/play-art/playable-sculpture/play-modules-primary-school-de-burgst-netherlands-annemarie-van-splunter-2003/ (Erişim tarihi: 4.2015).

Url9< http://www.viralnova.com/reused-phone-boxes/ (Erişim tarihi: 4.2015).

Url10<http://www.archdaily.com/579041/bundesgymnasium-gainfarn-bad-voslau-franz-architekten/ (Erişim tarihi: 4.2015).

Url11<https://www.pinterest.com/pin/433682639092223574/ (Erişim tarihi: 4.2015).

Url12<https://www.pinterest.com/pin/518617713311593635/ (Erişim tarihi: 4.2015).

Url13<https://pricetags.wordpress.com/2012/10/04/images-of-brisbane-colour-2/ (Erişim tarihi: 4.2015).

System Analysis Of Non-Patient Related Modules Of Hospital Information Systems Used In All State And University Hospitals In Turkey:

Halit HAMI. OZ[1]

Abstract

Hospitals are in the business of caring for patients, therefore, patient-centered, operations optimization-based, integrated information systems are the core of hospital management information systems. Successfully implementing patient care information systems (PCIS) in health care organizations is a difficult task. Hospital information system (HIS) developed for one country may not work in another country because the rules and regulations that these institutes are to follow are different from those of the United Kingdom or the United States of America where most of the HISs have been developed. Especially, the implementation of a PCIS which has been developed elsewhere is more likely to end up with 'failure' than 'success' in another country since "programs and jokes do not travel". These HIS programs almost have to be rewritten from the scratch, therefore, costs to tailor packages to fit the needs of the local market and integrate them are often outrages or unknown. There are several failures of implementation of foreign hospital information systems in Turkey due to the software companies' lack of knowledge about how the state and university hospitals function in the country. Fortunately, six hundred and eighty state hospitals and forty nine university hospitals in Turkey have to follow and comply with the same rules and procedures that are set by the ministry of health. They all conduct or have to conduct their business more or less in a very similar fashion and they do make a huge market for software companies in the business of developing and selling hospital information system. There has been no previous study of System analysis of non-patient related modules of Hospital Information Systems used in all state and university hospitals in Turkey. In this paper, it is the first time, system analysis and modules of the state and university hospitals management information system are given in detail so that they can be used as reference by the people who need to know how the state and university hospitals conduct their business in Turkey.

***Keywords**: Hospital Information System, Medical Records, Management Information System, System Analysis of Hospitals, Patient Care Systems, Hospital Information System Analysis in Turkey, Clinical Information System*

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1. Introduction

Hospitals are in the business of caring for patients, therefore, patient-centered, operations optimization-based, integrated information systems demonstrably enhance such care [1-48].

Successfully implementing patient care information systems (PCIS) in health care organizations is a difficult task. Especially the implementation of a PCIS which is developed elsewhere in a country is more likely to end up with 'failure' than 'success'. Moreover costs to tailor packages to fit the needs and integrate them in another 'foreign' environment are often outrages or unknown. These programs almost have to be rewritten from the scratch. The software developers are to learn and concentrate on understanding the specific sub-domains together with the corresponding local and cultural requirements. There are several failures of implementation of hospital information systems of foreign origin due to the software companies' lack of knowledge about how the state and university hospitals work in Turkey. These failures can not be reported by the author for ethical reasons even though we know all of them. They had to rewrite the entire hospital information system costing them millions of dollars way overdue their budget. Hospital information system developed for one country may not work in another country. Six hundred and eighty state hospitals and forty nine university hospitals in Turkey have to follow similar rules and procedures that are set by the ministry of health. They all conduct their business more or less in a very similar fashion. In this paper, system analysis and modules of the state and university hospitals management information systems are given in detail so that it can be used as reference by the people who need to know how the state and university hospitals conduct their business in Turkey.

2. Methods

A system analysis has been conducted in the 3000 bed Istanbul University Istanbul Faculty of Medicine Teaching Hospital, 300 bed Marmara University Teaching Hospital, 400 bed Kocaeli University Teaching Hospital, 400 bed Aydin State District Hospital, and a 1300 bed Sisli Etfal State District Hospital as part of the development of a computerized hospital information system. During this analysis, the functions, rules and procedures that have been followed by the hospital administration have been studied and the modules are described in detail.

3. Results

Circulating Capıtal
DEPOT MANAGEMENT
PROCUREMENT
LIBRARY SERVICES
PERSONNEL INFORMATION SYSTEM

Hospital administration is mainly comprised of circulating capital, depot management, procurement, personnel information systems and library services.

Circulating capital consists of general ledger, cash management, general reporting, financial planning, patient billing, and circulating capital purchasing.

Depot management consists of material ordering, material receipts, commodity control, commodity control yearly, stock issue, kitchen depot, fuel oil, vehicle gasoline, medical depot, and inventory control.

Procurement consists of purchasing, tendering, and government health insurance.

Circulating Capital
General Ledger
Cash management

General Reporting
Financial Planning
Patient Billing
Circulating Capital Purchasing

General Ledger

1. Cash on Hand, is the amount of cash held in the Circulating Capital Cashier's case for daily business operations.
2. Cash in Bank, is the amount of cash deposited by the main cashier of the hospital or the payments made by the third party payers for the bills of the no-pay patients in a state bank for business operations.
3. General Revenue, is comprised of

a- inpatient bed and nursing revenues charges,
b- fees for the outpatient clinical examination and consultation and for the Health Council Reports and minor procedures performed at the outpatient clinics,
c- inpatient baby delivery and surgical revenues,
d- central laboratory, special laboratories, radiology, EEG, ECG, pathology, endoscopy etc. and special departments revenues,
e- pharmacy and medical supplies revenue,
f- donations and other revenues.

4. Management and Administrative Expenses; this account is broken down into types as follows;

a- accounting staff salaries,
b- family compensation,
c- birth, death and funeral compensation,
d- treatment, clothing, food and fuel compensation,
e- retirement fund payments,
f - travel expenses,
g- stationary and office equipment expenses,
h- staff transportation expenses,
i - medical supplies and drug expenses,
j - food and fuel oil expenses,
k- furniture and inventory expenses,
l - medical equipment expenses,
m-maintenance and repair expenses,
n- contingency expenses.

5. Warehouse account, is a temporary holding account for goods newly received to depots. This account is cleared immediately after payment of an invoice and the amount is then transferred to management and administrative expense accounts.
6. Accounts receivable, is the revenues owed to the university hospital.
7. Accounts payable, is the unpaid expenses of the university hospital.
8. Fixed Assets and Furniture, this is an account for recording capital assets.
9. Depreciation, this account is for accumulating depreciation of Fixed Assets.
10. Circulating capital, the amount of revenues provided to the hospital as described in General Revenue and by the government at the time of establishment of the hospital and by the rector of the university whenever operating funds are insufficient.
11. Unpaid capital, the amount of funds repaid from the hospital to the government through the rectorship.
12. Profit and Loss, this account is periodically used to close the Revenue and Expenses account.
13. Advance account; this is a small cash account used for small purchases. It is closed and balanced every 30 days.
14. 5% Headquarters share; records amount paid annually to the Headquarters of Circulating Capital Administration (5% on gross revenues).

Cash management

This section receives patient and other hospital revenues and disburses cash to cover expenses.

The cash receiving section receives cash from patients or other sources, writes and prints out a receipt through the computer and records the data in the computer. There are eight cash receiving points within the hospital.

a. The patient comes to one of the eight cash receiving points, Outpatient Admissions, Archive, Central Laboratories, Radiology, Special Departments such as pathology, endoscopy etc. and Inpatient Admission/ Discharge and pays his fee or makes a deposit and receives a receipt generated by the computer.
b. The cash amount is entered in to the computer. On a daily bases cashiers process approximately 100 inpatients and 800 outpatients.
c. Patient discharge/billing makes the final bill, prints it out of the computer and the Cash Receiving who is the same person that is making the discharge receives the cash if the patient owes a balance.
d. At the end of each day cashiers' cashbook list are printed from the computer and copies of the Receipts are given to the Main Cashier for general reporting function to record in official cashbook of the hospital using a pen with ink as required by law.

Cash Disbursing is responsible for disbursing cash to cover hospital operating expenses paid out of Circulating Capital.
a. Patient discharge/billing sends a disbursement voucher printed from the computer to Cash Disbursing if the patient is due a refund. Accordingly, Cash Disbursing issues cash to the patient and the patient signs the voucher acknowledging the refund.
b. Head of Circulating Capital sends a disbursement voucher to Cash Disbursing (an accountant appointed by the Finance Ministry) as required as authorization for vendor payments. Accordingly, Cash Disbursing issues a check or cash to the vendor and the vendor signs the voucher acknowledging the receipt of cash against his invoice.
c. These vouchers are held in a file and turned over to General Reporting at the end of each day.

General Reporting
This function is responsible for auditing daily cash receipts and disbursement, recording transactions and reporting to the director of the hospital.

Cash Balancing (main cashier) reviews the cash receipts and disbursements, verifies balances and prepares the daily cash voucher entry.

a. receives the cashier's cashbook list from the computer and voucher files from Cash Receiving and Disbursing on a daily basis.
b. balances and totals the cash drawers and verifies the cash balances.
c. prepares a final disbursement voucher for transmission of cash to the bank account.
d. the cash receipts and disbursement data is turned over to the Recording office at the end of the day.

Recording reviews the cash voucher, prepares disbursement vouchers and records transactions to the general ledger.

a. Recording receives cash receipts data of different cashiers in the hospital and prepares

a daily summary sheet which details the revenues of the different cashiers.
b. Recording uses the revenues summary and the individual disbursement vouchers to record accounting information to the General Ledger.

c. Receives the Purchasing and Goods request form from the Circulating Capital Purchasing function, reviews the data, prepares a cash disbursement voucher and sends the disbursement voucher to the Cash Disbursing function.
d. On a monthly bases, Recording summarizes the General Ledger and submits an operating report to the director of the hospital.

Financial Planning
This function is responsible for developing the annual budget of receipts and expenditures for the Circulating Capital funds. The budget for the coming year is prepared and submitted to the Dean of the Faculty of Medicine.

a. Using the itemized revenue data and the expenditure data from the General Ledger, Financial Planning prepares a preliminary budget and submits it to the Dean of the Faculty of Medicine.
b. Dean's office reviews the preliminary budget, makes revisions as it sees fit, and returns a final operating budget to the Financial Planning.
c. The final budget is transmitted to the head of the Circulating Capital to be submitted to the university rector.

Patient Billing
This module is responsible for the billing of the patients' charges entered into the computer during their stay in the hospital if they are inpatient or their treatment period if they are outpatient.

a. Inpatients discharge is made from the Inpatient Clinic secretaries.
b. From the data in the computer a final bill is prepared simply by entering the patient protocol number into the computer.
c. At this time the patient's account in the computer is checked if he/she deposited any amount of money at the time of admission.
d. If the patient owes some additional amount of money he/she pays to cashier at the discharge office. If the patient is due a refund, a special document is prepared from the computer by the person who discharges the patient and the patient is sent to Cash Disbursing.
e. If the patient is a no-pay patient (i.e., a patient whose employer will pay his medical expenses), the bill is retained in the Discharge Office and on a monthly basis the invoice is sent to the patient's employer. If the patient does not have enough money and cannot pay his bill immediately he is sent to the hospital director to clarify his situation. Either a discount is made to the patient or the patient signs a note to pay his bill in monthly installments.

Circulating Capital Purchasing
This module is responsible for purchasing supplies and materials which are not provided from the operating budget of the University Rectorship.

1. The Chief Administrator receives requested materials from the various clinics entered into the computer.
2. The Chief Administrator sends this request to Circulating Capital Purchasing for a check of the Hospital budget and cash balance available.
3. The Circulating Capital Purchasing committee oversees the proposed purchase.
4. If the committee accepts the request, the required forms using the same data are printed out to be signed, then the vendors are contacted and bids from at least 3 companies are requested.

5. The Circulating Capital Purchasing committee reviews the bids from the vendors and determines the most appropriate bid.
6. The winning vendor is notified and they deliver the goods to the depot.
7. An inspection committee in the depot inspects the quality and quantity of the goods and enters the inspection report in to the computer and the report is printed out to be submitted to the Chief Administrator for payment approval.
8. The approved inspection report, the purchased material receiving form (which is prepared by the depot using the same data entered previously), and the invoice are printed and sent to the Circulating Capital Purchasing for a price check and payment.
9. The vendor dossier, including all the forms mentioned above, is handed over to Cash Management for preparation of a disbursement voucher.

DEPOT MANAGEMENT

Material Ordering
Material Receipts
Commodity Control
Commodity Control Yearly
Stock Issue
Kitchen Depot
Fuel Oil
Vehicle Gasoline
Medical Depot
Inventory Control

Material Ordering

This module describes the method by which the hospital orders material which is in stock and for material that has to be special ordered.

1. Each clinic or hospital organization orders items with a common Inventory Request form using the hospital computer system. This form describes the requested material and quantity.
2. This form requires the approval of the Chief Doctor, Property Accounting, Deputy Administrator and the Chief Administrator.
3. The form has 2 copies, a copy is maintained by the requester and the second copy is used to complete the order by the depot.
4. Upon receipt of this request, Depot personnel complete the form and checks the items ordered in the stock data base in the system. This provides the exact description of the item in the stock and provides the latest on hand inventory balance of the stock.
5. Office supplies are ordered from the Government Supply Depot. In the event the Government stores cannot fill the order, the order is completed on the local market.
6. The material is received through the normal receiving procedure.

Material Receipts

This operation describes the method in which the Depots receive and inspect material.

1. The selected vendor delivers the specific parts and the Depot Personnel prepare a receiving document in the computer, which describes the material received. In the presence of the vendor, the material is counted and the quality inspection check is performed. Any difference in the count or quality is adjusted on site.
2. After completion of this step, three copies of the final receiving report are prepared and printed out to be signed by the Depot Chief, Requester and the Deputy Chief Administrator.
3. The Quality Inspection form is forwarded to purchasing for future utilization.

4. The vendor, with a copy of the up-to-date receiving report prepares his final invoice and submits his invoice and final receiving document to Purchasing for payment.
5. Purchasing matches the vendor invoice and the receiving document with the Quality Inspection form. If the package is complete, purchasing submits it to the Depot Management for the final match.
6. Depot Management matches his receiving file against the submitted vendor invoice. If all records match, data is entered to the computer for the final payment form to be prepared. Upon completion of this form in the computer, it is submitted to Purchasing for final payment and 2 copies of the document are sent to Inventory Control. At this time the inventory records data base is updated.
7. Purchasing approves the document and gives the vendor his formal package for payment.

Commodity Control

This module describes the commodity control function within the Depot. This is the basic in and out control of parts and materials.

1. When Commodity Control receives the authorization from purchasing that the vendors invoice has been approved, Commodity Control updates the inventory records to show the latest inventory balances.
2. A copy of the final authorization package is sent to the Inventory Control Section.
3. The Commodity Control function maintains the data base for all materials within the hospital. This data, if all records processing is complete and accurate, provides the information about the material within the Inventory Control area.

Commodity Control Yearly

This module describes the data base structure of the yearly activity of the physical inventory.

1. A yearly physical inventory is taken of all inventory within Depots and is recorded onto a form. This is a yearly inventory results form.
2. All detailed transactions of the hospital inventory and the entire year's history of that material or part are printed out at the end of the year.
3. If the final inventory results are greater than the list provided from the computer, it is recorded to the stock data base as new inventory receipts.
4. The final inventory results are printed out to a special form. This form provides all the details required to trace the inventory accounts from last year's carry over to this year's receipts issues.
5. The final form is completed by Inventory Control and submitted to the Dean's Office and Government Audit.

Stock Issue

This function describes the parts and material issue procedure used to issue stock and material from depots.

1. First, the requests are entered to the computer by the clinics' secretaries or the other personnel. Upon receipt of a request form from the computer and proper authorization, a picking list is prepared.
2. If the material or parts are totally available the material order is filled. If the material is partial or out of stock the requester is notified. If parts have to be ordered a new request form has to be generated.
3. Upon completion of the Parts Issue cycle, the Inventory Control and Commodity Control sections are notified and they

update their set of Inventory data base. This is achieved with the results of the actual picking list.

4. At this point of the procedure, both data bases have been updated for the Depot Parts Control and the Inventory Control section.

Kitchen Depot

The meal order form I simple providing selection between menus and allowing selection of meals in accordance with doctor's special orders. The daily meal orders are entered or updated for each diet patient in the morning and in the afternoon. A list is printed out every day at 10 Am. and 3 p.m. showing the day total, service total and the room total of the meals ordered, and also the bed number, patient identification number, name and last name of the patient and the meal ordered for each patient.

This procedure describes the function by which the kitchen receives and issues inventory.

1. Every week the dietician prepares a new menu for the hospital. This will include only normal diets.
2. From the computer every day the total number of people that are employed by the hospital and the total number of patients in the hospital are printed on a special form to be submitted to the kitchen.
3. The clinics' secretaries provide a list of the kinds of meals ordered by physician for the patients on a special form. This is the 'Daily Meal Requirement' form and it is summarized in another special form by the computer using the same data base. The Clinic Summarization Form is printed out and submitted to the kitchen depot. The kitchen depot prepares a Meal Distribution Form.
4. With the total number of people to feed and the total number of types of meals, the kitchen depot computer program computes the total food requirements for the following days' meals on a special form.
5. The vendors are then notified and the food, vegetables and fruits ordered are delivered and inspected for the next days' meal preparation.
6. Normal receiving and payment procedures are used and food items are tested for quality and freshness.
7. On food items that cannot be counted, they are weighed and the results are recorded on the form.
8. Every day from 10:30 to 11:00 a.m. and 15:00 to 15:30 p.m. the kitchen staff obtains the inventory for the next day's meal preparation.

Fuel Oil

This procedure describes the function by which the hospital receives fuel oil.

1. The same vendor is used for fuel oil and gasoline for the hospital vehicles.
2. The vendor submits his invoice on a monthly basis.
3. All remaining depot management procedures are utilized.

Vehicle Gasoline

This procedure describes the function by which the hospital receives gasoline for its motor vehicles.

1. The same vendor is selected for both the fuel oil and vehicle gasoline.
2. The hospital driver prepares a credit slip showing the amount of gasoline required. This form is approved by Deputy Chief Administrator. The driver submits the

approved credit slip to the service station. The service station attendant maintains the slips for the entire month and at end of each month prepares his invoice with the credit slips for final payment.

Medical Depot

This procedure describes the functions involved in the ordering and issuing of medical supplies and drugs.

1. The inventory is received on a required basis from vendor.
2. The standard receiving, inspection, and payment procedures are utilized in this function.
3. The computer generated medical history form is the history of the drug usage and is utilized to generate next years requirements.
4. The computer generated drug ledger form is the history of the medical supplies equipment and the total drug usage for the hospital.
5. To release drugs, supplies or medical equipment from the pharmacy for a patient, a completed medical request must be entered into the computer. For normal operating supplies, the standard computerized request form is used for the medical depot.
6. On a daily basis the clinic secretaries enter the orders into the computer for the drug and medical requirements from the patient tables.
7. On a daily basis the pharmacy prints out the medical needs using the data entered by the clinic secretaries. Upon receipt of the drug and medical requirements the pharmacy divides the request into four types of inventory.
8. The medical request items are filled and the request information updates the medical consumption data base. The medical and drugs are packaged and the computer generated forms are used to identify the clinic location and the patients name.
9. All completed transactions are updated to a special summary files in the data base.
10. The remaining procedures are the same as the normal depot management procedures.

Inventory Control

This module describes the duties and responsibilities of the inventory control section. This section has the overall responsibility for all materials and the accountability of such.

1. Employees can obtain supplies and equipment from inventory control for their own job related use or for the clinic they are assigned to.
2. When the employee terminates from the hospital they are required to clear these inventory items and return all inventory goods.
3. These items are accounted for during the normal yearly inventory cycle.
4. When an inventory item is damaged, a Damaged Inventory Form must be completed and the data is entered into the computer. Inventory Control will determine if the item can be repaired or replaced.
5. The damaged inventory items data are summarized in the Yearly Summarized Damaged Inventory data summary file which becomes part of the normal yearly inventory records.
6. The normal hospital inventory is taken every two years and all items are accounted for. The inventory information is submitted on the detailed inventory record.
7. The total hospital inventory including food, medical supplies, drugs and all

other inventory items are submitted on the Inventory Description Book form. This is the next higher level of inventory records.

8. The general summary information is posted to the total Inventory History Form. This is a posting of both medical and general inventory status for both medical and general inventory.
9. The above information is summarized and posted to the Total Detailed Inventory Form. This is the total detailed inventory and current year purchased items for all depots.
10. All inventory items are summarized in a different form which represents the inventory with values expressed in Turkish Currency amounts. This final report is submitted to the Chief Doctor and the Rectorship.
11. Inventory Control is notified of all issues and receipts of inventory for all depots within the hospital.

PROCUREMENT

This procedure describes the overall function of the Purchasing Department as well as the hospital insurance payment program.

Purchasing
Tendering
Government Health Insurance

Purchasing

This procedure describes the normal purchasing function of the Purchasing Department.

1. The Purchasing Department buys from two types of vendors - Government and Commercial.
2. The invoice approval on incoming inventory is a major function of the Purchasing Department.
3. The Purchasing Department is responsible for the financial reporting of the current budget expenses.
4. Discounts are given on volume purchases and the lowest bid with the best quality product wins the bid.
5. There is no competitive bidding on purchases of less than 7 thousand Turkish Lira.
6. Technical specifications are provided to the vendor.

Tendering

This procedure describes the tendering function of the Purchasing Department.

1. Tenders are for purchases over 7 thousand Turkish Lira ($3000).
2. General specifications are sent to the rectorship for new estimates.
3. A minimum of three bidders are required for tendering and purchase estimating.
4. Upon receipt of the estimated prices from the rectorship, the technical and administrative specifications are prepared.
5. Newspaper ads are placed in the local and government newspapers with the required bidding information. The technical and administrative information is submitted to the vendors.
6. Purchasing maintains copies of the newspaper ads.
7. 7. Purchasing prepares for the bidders conference.
8. Vendors submit their closed bids.
9. Purchasing announces the winner. The winner posts a performance and reference book and enters into final contract negotiations.
10. A final report, outlining the results of the tender, is submitted to the Chief Doctor of the hospital with the announcement of the winner and the award price.

11. The purchasing council which is comprised of a Chief Doctor, Head of the Circulating Capital, Hospital Administrator and Chief Cashier and a member of Purchasing Department meet weekly for the purchase of the materials requested and payment to companies. Purchasing is responsible in describing the actual expense against the general ledger budget.

Government Health Insurance

1. The employees of the hospital are covered by a form of medical insurance provided by the government.
2. All employees are required to submit all invoices and other medical bills and related vouchers to the purchasing department in the rectorship.
3. The families of the employees are also covered by this government insurance plan.
4. Medical treatment inside the hospital is paid from the same special budget that is allocated for the medical expenses in the rectorship.
5. The medical services that are performed outside the hospital are paid with the normal invoicing procedures from the same budget.
6. The following is the types of medical services offered:
7. Medical Treatment, Dental Services, Eyeglass Services, Medical Operations, Prescribed Drugs and Medical Supplies.
8. The bills for the treatment of the civil servant employees in the hospital are also sent to the rectorship for reimbursement.

Library Services

Documentation, scientific evaluation, scientific publication, information about subjects, periodicals and textbooks in the library, and PubMed and Web of Science search are available in the hospital library computer system.

Personnel Information System

Payroll and Personnel administration are carried out by using the computer system. Payments to the faculty members are made according to their performances derived from the data in the patient care system.

4. Discussion

The patient's care systems in the country continuously integrate nursing, physician, and departmental activities as well as the other administrative activities. Any item purchased through the purchasing department should be used for patients or services in the hospital. For example, if a laboratory kit is purchased for one test and a certain number of that test should be run with that kit in the laboratory, a comparison of the laboratory performance data with the purchasing department data gives information about the laboratory activities. All information about a patient relevant to any administrator, chief director of the hospital, should be available at any time, provided that the administrator is authorized to use such information. For instance, should a pathologist want information regarding a charge was made to a patient for a slide examined, this should be available instantaneously at the pathologist's desk. Similarly, should a physician want to see if the surgery performed on his patient is charged to the patient's account, the information should be available instantly.

I have personally seen many world famous companies which entered the hospital information systems market in Turkey had to rewrite their entire programs from the scratch costing them hundreds of thousands of dollars due to the lack of knowledge about how the

state and university hospitals function. In one case 1.6 million dollar HIS program had to be rewritten from the scratch costing the software company hundreds of thousands of dollars and paying for compensation for the delay of the implementation of the program. This company was later banned from the other HIS projects in state hospitals because of its failure in its first project in a big state hospital. It is true that 'programs and jokes do not travel'. The work flow chart of the state and university hospitals and the data types and length of each field of records of the tables about the information kept in each department and module have already been studied and are readily available. This information will be published in a separate paper and can be obtained from the author upon request.

5. Summary and Conclusion

Foreign software companies should study and learn the way the hospitals conduct their business and the culture of the local people working in these hospitals before they think of winning the international bids as part of a big turn key hospital projects. They have to work with the local people who know the system very well and see if their programs are suitable to meet the needs of the local people. They should not try to impose their program on to the local people because they all have to follow certain rules and regulations set by the ministry of health of that country.

REFERENCES

[1] Aanestad, M., Jolliffe, B., Mukherjee, A., et al. Infrastructuring Work: Building a State-Wide Hospital Information Infrastructure in India. *Information Systems Research* 2014 25(4):834-845.

[2] Adams, MB., Kaplan, B., Sobko, HJ., et al. Learning from Colleagues about Healthcare IT Implementation and Optimization: Lessons from a Medical Informatics Listserv. *Journal of Medical Systems* 2015 39(1): article number 157.

[3] Aller RD: Maintaining the quality of laboratory services in a cost-containment environment. *Clin Lab Med* 1985, 5:623-634

[4] Barnett GO, Jenders RA, Chueh HC: The computer-based clinical record-where do we stand ?. *Annals of Internal Medicine* 1993, 119 (10):1046-1048.

[5] Berg M: Implementing information systems in health care organizations: myths and challenges. *Int J of Med Informatics* 2001, 64 (2-3):143-156.

[6] Connelly DP: Integrating integrated laboratory information into health care delivery systems. *Clin Lab Med* 1999, 19(2):277-97.

[7] de Mello PSC, Almeida RMVR, Pereira WCA: A computerised information system for the analysis of hospital admission flow and characteristics. *Int J of Med Informatics* 2001, 61 (1):11-20.

[8] de Velde RV: Framework for a clinical information system. *Int J of Med Informatics* 2000, 57:57-72.

[9] El-Gamal SS, Ghoneim MA: A specialized hospital information systems. *Med. Inform* 1987, 12 (3):203-215.

[10] El-Gamal SS: A computer based clinical information system. *Method of Information in Medicine* 1987, 26:189-194.

[11] Elwy, A. R., Bokhour, BG.,Maguire, EM. et al. Improving Healthcare Systems' Disclosures of Large-Scale Adverse Events: A Department of Veterans Affairs Leadership, Policymaker, Research and Stakeholder Partnership. *Journal of General Internal Medicine* 2014 29(4):S895-S903.

[12] Fox, J., Gutenstein, M., Khan, O. et al . OpenClinical.net: A platform for creating and sharing knowledge and promoting best practice inhealthcare. *Computers in Industry* 2015, 66:63-72.

[13] Ferrara FM: The CEN healthcare information systems architecture standard and the DHE middleware. A practical support to the integration and evolution of healthcare systems. *Int J of Med Informatics* 1998, 48 (1-3):173

[14] Friedman BA: The potential role of physicians in management of hospital information systems. *Clin Lab Med* 1990, 10:239-250.

[15] Friedman BA, Dieterle RC: Integrating information systems in hospitals. Bringing the outside inside. *Arch Pathol Lab Med* 1990, 114:3-16.

[16] Friedman BA, Martin JB: The physician as a focus of authority, responsibilty, and operational control of medical systems. *J Med Syst* 1990, 12: 389-396.

[17] Hao, WR; Hsu, YH; Chen, KC; et al. LabPush: A pilot study of providing remote clinics with laboratory results via short message service (SMS) in Swaziland, Africa - A qualitative study. *Computer Methods and Programs in Biomedicine* 2015 118(1):77-83.

[18] Huston TL, Huston JL: Security in the management of information systems. *Health Care Superv* 1998, 16 (4):28-34.

[19] Kinsey TV, Horton MC, Lewis TE: Interfacing the PACS and the HIS: results of a 5-year implementation. *Radiographics* 2000, 20 (3):883-91.

[20] Korpman RA: Health Care Information Systems: Patient-Centered Integration Is the Key. *Clin Lab Med* 1991,11 (1):220-226.

[21] Kun KC, Watanbe R, Kaihara S: Hospital Information Systems in Japan. *Methods of Information in Medicine* 1986, 25:4-14.

[22] Leisch E, Sartzetakis S, Tsiknakis M, Orphanoudakis SC: A framework for the integration of distributed autonomous healthcare information systems. *Med Inform(Lond)* 1997, 22 (4):325-35.

[23] Lelliott P: Making clinical informatics work. *BMJ* 1994, 308:802-803.

[24] Markin RS: Recet trends in clinical laboratory automation. *Clin Lab Manage Rev* 1998, 12 (3):176-180.

[25] McDonald CJ, Overhage JM, Tierney WM, Dexter PR: The Reginstrief Medical Record System: a quarter century experience. *Int J Med Inf* 1999, 54 (3): 225-53.

[26] Ostbye T, Moen A, Erikssen G, Hurlen P: Introducing a module for a laboratory test order entry and reporting of results at a hospital ward: an evaluation study using a multi-method approach. *J Med Syst* 1997, 21 (2):107-117.

[27] Oz HH, Akdas A, Cantez T, Sabuncu H: General guidelines for computerized medical information system on patient care: example of some state and university hospitals in Turkey. *Marmara Medical Journal* 1997,10 (3):158-166.

[28] Oz HH, Sur H, Piskinsut F, Ertas A: Turkiye'de devlet hastaneleri yonetim bilgi sistemi calismalari. *Modern Hastane Yonetimi* 1998, 2 (3):25-31.

[29] Oz HH, Minareci O, Cantez S: University of Istanbul Faculty of Medicine Radiology and Nuclear Medicine Information Systems. *Turkish Journal of Nuclear Medicine* 1996, 5 (3):186-191.

[30] Ozsari H, Oben K, Merih K, Oz HH, Pozanti S, Ertem C: Hastanelerde bilgisayar otomasyonu: Forum. *Modern Hastane Yonetimi* 1998, 2 (5):12-21.

[31] Reiser SJ: The clinical record in medicine. Part 2: Reforming content and purpose. *Ann Intern Med* 1991, 114 (11):980-5.

[32] Schadow G, Fohring U, Tolxdorff T: Implementing HL7, from the standard's spesification to production application. *Methods Inf Med* 1998, 37 (1):119-23.

[33] Shortliffe EH: Medical informatics: An emerging academic discipline and institutional priority. *JAMA* 1990, 263:1114-1120.

[34] Scherrer JR: The expected usefulness of the hospital information system to come. *Methods of Information in Medicine* 1988, 27:51-52.

[35] Sothon G, Sauer C, Dampney K: Lessons from a failed information systems initiative: issues for complex organizations. *Int J Med Informatics* 1999, 55 (1):33-46.

[36] Teodolina A: A communication architecture for hospital information systems. *Comput Methods Programs Biomed* 2000, 62 (1):59-68.

[37] Treseder P, Williams P: The common principles of health informatics standardization that require exchange of information between the standardization bodies of different countries. *Int J of Med Informatics* 1998, 48 (1-3):39-44.

[38] Vassilacopoulos G, Paraskevopolou E: A process model basis for evolving hospital information systems. *J Med Syst* 1997, 21 (3):141-153.

[39] Waytt JC: Clinical data systems, part 1: data and medical records. *Lancet* 1994, 344:1543-1547.

[40] Waytt JC: Clinical data systems, part 2:components and techniques. *Lancet* 1994, 344:1609-1614.

[41] Waytt JC: Clinical data systems, part 3: development and evaluation. *Lancet* 1994, 344:1682-1688.

[42] Weber D, Schubiger G: Electronic clinical data systems. *Lancet* 1995, 345: 454-455.

[43] Weilert M: Implementing Information Systems. *Clin Lab Med* 1991, 11(1): 41-52.

[44] Weisskopf, M., Bucklar, G., Blaser, J. Tools in a clinical information system supporting clinical trials at a Swiss University Hospital. *Clinical Trials* 2014 11(6):673-680.

[45] Westberg TE, Mann NH, Spengler D: Integrating and presenting clinical and treatment outcome data for cost-effective case management. *Comput Biol Med* 1997, 27 (1):31-47.

[46] Williams JG: The use of clinical information to help develop new services in a district general hospital. *Int J Med Inf* 1999, 56 (1-3):151-9.

[47] Wu, RR., Kinsinger, LS., Provenzale, D. et al. Implementation of New Clinical Programs in the VHA Healthcare System: The Importance of Early Collaboration Between Clinical Leadership and Research *Journal of General Internal Medicine* 2014 29(4):S825-S830.

[48] Young ST, Chang JS: Implementation of a patient-centered and physician-oriented healthcare information system. *Med Informa (Lond)* 1997, 22 (3): 207-14.

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