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BARBAROS DENİZ BİLİMLERİ
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Dr. Mehmet Bilge Kağan ÖNAÇAN
Milli Savunma Üniversitesi
Barbaros Deniz Bilimleri ve Mühendisliği Enstitüsü
Tuzla 34942, Istanbul - Turkey
Phone: +90 (216) 395 26 30 / Fax: +90 (216) 395 26 58

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RESEARCH ARTICLE

A HOLISTIC APPROACH FOR HR SELECTION AND PLACEMENT PROCESS: A MODEL PROPOSAL FOR MARITIME INDUSTRY

Alper ERTÜRK [1]*
Oğuz DEMİREL[2]
Mustafa POLAT [3]

[1] *Department of Management Information Systems, Düzce University*
** Corresponding Author: alpererturk@duzce.edu.tr*
[2] *Department of Management Information Systems, Düzce University*
oguzdemirel@duzce.edu.tr
[3] *Department of Management Information Systems, Düzce University*
mustafapolat@duzce.edu.tr

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ABSTRACT

Human resource management is one of the core functions and competences for companies operating in maritime transportation industry to enhance their sustainable competitive advantage in a dynamic business environment. Personnel selection and placement process considerably influences all areas and sub-functions of HRM regarding crew on board and thus it has been one of the most important topics in maritime HRM. This paper aims to propose a three-phase, integrated, comprehensible model that will provide an effective way and help the maritime companies in selecting the right person and placing him/her to the right job. In the first phase of the model, required and preferred skills and abilities of sailors are determined. In the second phase, how those skills and abilities are measured is established. In the third and last phase, a sound feedback and validation mechanism is established in order to validate the whole process, including developing a fuzzy complex multi-criteria mathematical model. This three-phase model based on a scientific approach is intended to be used by human resource managers as a decision support tool for choosing the right sailors.

Keywords: *Human Resource Management, Personnel Selection and Placement, Maritime Industry.*

ÖZ

Denizcilik sektöründe faaliyet göstermekte olan işletmeler için, dinamik bir iş ortamında sürdürülebilir rekabetçi avantajlarını korumak ve geliştirmek için, İnsan Kaynakları Yönetimi en temel fonksiyonlardan biridir. Personel seçme ve yerleştirme süreci de, özellikle gemi tayfası dikkate alındığında İnsan Kaynakları Yönetiminin diğer tüm alt süreçlerini önemli derecede etkilemektedir ve dolayısıyla denizcilik sektöründe en önemli İKY konularından biri haline gelmiştir. Bu çalışmada, denizcilik sektöründe faaliyet gösteren işletmelere, doğru insanı seçmek ve doğru pozisyona yerleştirmek için yardımcı olabilecek, üç safhalı, bütüncül ve geniş kapsamlı bir model önerilmektedir. Modelin ilk safhasında, denizciler için gerekli olan ve tercih edilen yetenek ve becerilerin belirlenmesi yer almaktadır. İkinci safhada ise, bu yetenek ve becerilerin nasıl ölçüleceği belirlenecektir. Modelin üçüncü ve son safhası ise, tüm sürecin geçerleme ve doğrulamasını sağlayacak olan süreci oluşturmakta ve bulanık mantığa dayalı karmaşık çok kriterli matematik bir model içermektedir. Üç safhadan oluşan bu model, doğru denizcileri seçmek üzere insan kaynakları yöneticileri tarafından kullanılabilecek, bilimsel yönteme dayalı bir karar destek aracı sağlamayı amaçlamaktadır.

Anahtar Kelimeler: *İnsan Kaynakları Yönetimi, Personel Seçme ve Yerleştirme, Denizcilik Sektörü.*

1. INTRODUCTION

Maritime industry and especially the ship management is one of the most complicated business fields including a substantial number of decision-making processes [1]. The performance and reputation of the maritime companies heavily depend on the availability of well-structured management processes, as well as an effective management style. The complex structure of the maritime transportation industry puts profound pressure on the management decision processes in a dynamic business environment having rapidly changing technology, market strategies, risks and several challenges.

The managers in this industry need well-designed tools and methodologies to effectively manage decision-making processes related to all areas of management. Need for modification and re-designing of the processes and adaptation of new approaches has been addressed in recent studies [2] [3] [4]. Thus, innovative approaches need to be investigated and appropriately adopted to the existing processes and procedures of organizations to enhance the existing managerial processes.

Human resource management is one of the core functions and competences for companies operating in maritime transportation industry to enhance their competitive advantage in a dynamic business environment. In recent years, the shortage of maritime human resources has been highlighted by several researches [5] [6]. In addition to the tremendous shortage in manpower of maritime industry, the human-based errors are still significantly stated as the main causes of ship accidents [7] [8] [9]. As the human-based errors and consequent risks have been shown the dominant factors in maritime accidents, quality of the crew of a ship on board is considered the crucial aspect of ship management. Issues on human resources such as quality and competency of crew, safety-related precautions, and crew performance monitoring can be considered critical human resource processes for ship management companies. A maritime company determined to achieve excellence should consider leadership, team-work, collaboration and effective communication that significantly contribute to developing and maintaining commercial and risk management abilities of the human resources and provide a competitive advantage for the shipping business [10]. Among all the sub-functions of human resource management, personnel selection and placement considerably influences all of those issues regarding crew on board and thus it has been one of the most important topics in maritime HRM, as well as in general HRM literature [11].

In addition to the required certifications and standards in accordance with International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) mandated by International Maritime Organization (IMO), characteristics of the jobs on board itself enforce maritime companies for employing well-trained and competent personnel on board ships. However, research has yielded that certifications alone are not enough to have a high-quality crew [2] [6] [12]. While emphasizing certifications are essential to prove a deserved level of knowledge, crucial value of skills and abilities of the crew are notably highlighted.

Thus, several studies have been conducted to help maritime organizations make effective personnel selection decisions. The personnel selection process generally deals with critical, yet complex issues. For instance, since all personnel attributes/characteristics are not equally important, thus properly setting the importance weights of different criteria to reflect the actual situations is important but so hard. Aggregating the measurement results and then ranking the applicants is another difficult area. Hence, significance and complication of the personnel selection process require effective analytical and holistic methods to provide a decision framework.

Most processes used in the maritime sector for personnel selection use regular personnel selection and placement models that are very common in other sectors. Selection and placement of new personnel are conducted based on current job descriptions and job characteristics. There are only a few models and approaches that has attempted to use some mathematical algorithms and computer-based systems [2]. However, to the best knowledge of the authors, none of them have integrated a validation phase integrated in the same selection and placement processes. Hence, this paper aims to close this gap and attempts to provide a sound and holistic approach to validate the process in order to increase the reliability of the system and to enhance the chance of choosing the most appropriate personnel.

Thus, this paper mainly concentrates on designing of a sound and comprehensive managerial process for personnel selection and placement for maritime companies. An effective skill and ability based personnel selection and placement process help the maritime companies in selecting the right person and placing him/her to the right job.

2. PERSONNEL SELECTION AND PLACEMENT PROCESS

In the recent HRM literature, several studies have been conducted on how resumes, interviews, job knowledge tests, proficiency tests, cognitive tests, and personality tests are used in HR selection and placement process to help HR managers make better personnel selection decisions [13]. Research has also shown that measuring personality of candidates is a critical issue in the initial stage of recruitment process [14]. Moreover, assessments of knowledge, experience, job proficiency, performance, practice-based skills, and competencies constitute other important issues in recruitment process [15].

Although there are several effective procedures of the personnel recruitment models in literature, only a few have practically achieved to implement a process to validate their selection and placement process and methodologies. With a sound and well-designed validation process, the current approaches and practical applications can be enhanced in order to support personnel selection and placement in the shipping industry, which has a very specialized job environment requiring a particular expertise.

The proposed model in this study ensures an effective validation of the selection and placement process from a wider perspective, suggesting a sound and comprehensive three-phase process following a holistic approach.

2.1. First Phase: Determining Required Skills and Abilities

The first phase of the proposed process includes determining the required skills and abilities of the specific job on board ship. First step of this phase is to examine the outputs of the previous job analyses, such as job descriptions and job specifications. By doing that, it will be possible to learn the prerequisite personal requirements, such as education, job experience, and specific skill sets. It will also be possible to learn the tasks and responsibilities in the scope of the job. As each task requires different skills and abilities, tasks defined in the job descriptions will be examined in detail to understand what kind of skills and abilities are required for that specific job. In addition to determining the list of skills and abilities, examining the tasks in detail will also reveal the relevant importance of each specific skill for that job. This component is going to be determined by considering the weight of each task for that job and the weight of each skill for each task.

Second step of the first phase is to apply a questionnaire to the current crew in various posts of the ships. In the questionnaire, the crew will be asked which skill and ability is required to do his/her job and to what extent those skills and abilities are actively used. Although it is not a direct measure of how often those skills and abilities are actively used, as the survey will be applied to the crew who are currently practicing their written job descriptions, a valuable information about how much those skills and abilities are practically used can be retrieved. A sample list of tests and a sample list of skills and abilities for a specific job on board are presented in Table 1.

As the third step, a comprehensive literature search will be conducted to see what skills and abilities are determined in the HRM literature for specific jobs on board ships. Then, a list of required skills will be generated through this review. This information is going to be used to validate and enrich the list of skills and abilities that we will identify through the first two steps of this phase.

2.2. Second Phase: Determining How Required Skills and Abilities will be Measured

After the first phase, a validated list of required skills and abilities for each different job on board ships will be obtained. Second phase is related to determining how those skills and abilities will be measured by using various types of tests and test equipment. Thus, in the first step of the second phase, test methods and equipment to measure the level of each skill will be determined. In order to be able to measure the actual levels and to determine the required levels of each skill and ability, an appropriate test method will be determined. This method may be a written test, such as cognitive ability tests, or a test that can be conducted by equipment, such as psychomotor tests.

Second step of this phase is to identify the validity and reliability of the test equipment. Validity here means to identify if the test equipment measures the right skill and ability. Since validation process is somewhat complicated and needs further measurement, such as actual performance measures, predictive validity will be conducted in the third and final phase, which will be explained later.

Table 1. Sample lists of Tests, Skills and Abilities

<table>
<tr><td colspan="3">Sample Job on board ship: Mass Communication Specialist</td></tr>
<tr><td>Sample List of Tests</td><td colspan="2">• Arithmetic reasoning,
• Verbal skills,
• Spatial ability (three-dimensional space)
• Computational ability
• Clerical (administrative) skills
• Form perception
• Motor coordination
• Manual dexterity
• Finger dexterity
• Communication skills</td></tr>
<tr><td rowspan="4">Sample List of Required Skills and Abilities</td><td>Knowledge</td><td>• Native language
• Foreign language
• Communication and media
• Computers
• Telecommunication equipment
• Administration</td></tr>
<tr><td>Skills</td><td>• Verbal skills
• Writing skills
• Reading skills
• Persuasion skills
• Time management skills
• Coordination skills
• Interpersonal communication skills
• Organizing skills</td></tr>
<tr><td>Abilities</td><td>• Understanding
• Decision making
• Problem solving
• Dissemination of information
• Categorization
• Perception speed
• Arithmetic reasoning
• Computational ability
• Spatial ability
• Dexterity</td></tr>
<tr><td>Working Style</td><td>• Attention to details
• Reliability
• Persistence
• Endurance
• Working independently
• Taking initiative
• Responsibility
• Self-control
• Working in harmony
• Effort
• Enthusiasm</td></tr>
</table>

Reliability here means to identify the test equipment correctly measures the intended skill and ability. Reliability is planned to be proved by test –retest methodology. Some tests will be planned to be conducted more than once in accordance with a pre-planned schedule, thus the results will be compared to support the reliability of the specific test equipment.

Third step is to determine the actual meaning of the measurement results. For example, if we assume that a candidate took a hand-eye coordination test and had a result of 48 seconds. The purpose of this step is to interpret this result and explain what this 48 seconds means from an actual performance perspective. By doing so, threshold values, as well as upper- and lower-level boundary values for each skill will also be determined.

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2.3. Third Phase: Designing a Predictive Validation Process

Phase three is probably the most crucial part of the whole process. This phase is actually designed to establish a sound feedback and validation mechanism in order to validate the whole process, including measurements and results.

First step in this phase, every sailor and candidate will be tested using the pre-determined test method. Measurement results will be recorded for each individual. On the other hand, real performance measures of all sailors on board will be assessed during actual operations using same variables.

Then, since we will have test results and actual performance measures, correlation and regression analyses will be used if there is any relationship between test results and actual performance measures. Any association between those factors will provide a conclusion about the level of predictability and thus validation of the testing and measurement system of the proposed process.

Furthermore, a mathematical model incorporating fuzzy logic is going to be proposed as a tool for implementing multiple criteria personnel selection problem. In this method, identification of hierarchy and the importance weights of different criteria will be the key factors in using fuzzy logic. A fuzzy complex multi-criteria decision-making problem incorporating personnel selection process is going to be broken down and structured as a hierarchy of interrelated decision elements.

Once a mathematical model incorporating fuzzy logic is developed, it will be utilized to discover the nature of those associations among test results and actual performance measures. Once a validated model is developed, measurement system will be able to be rectified and further our whole selection process may be revised and corrected accordingly.
Proposed Three-Phase Personnel Selection and Placement Process is presented in Figures 1 and 2.

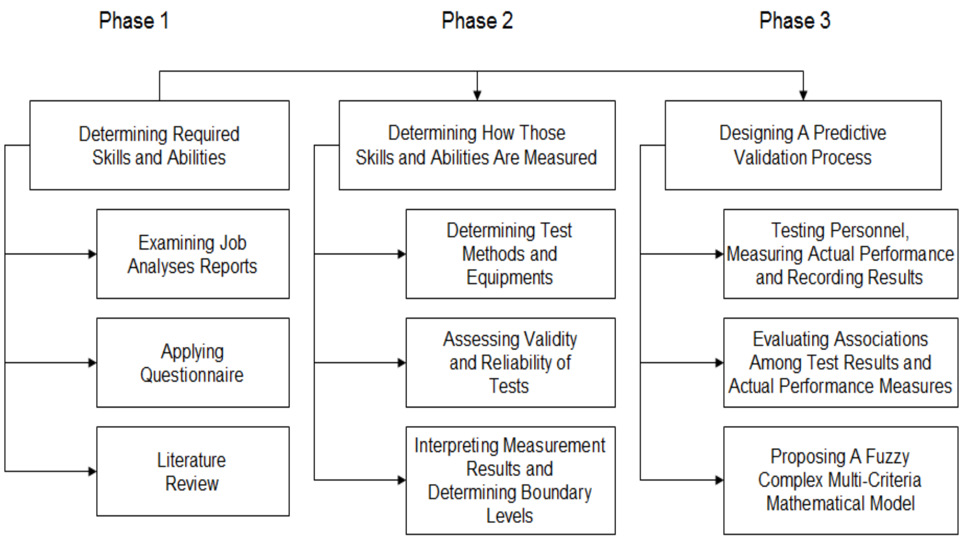

Figure 1. Three-Phase Model

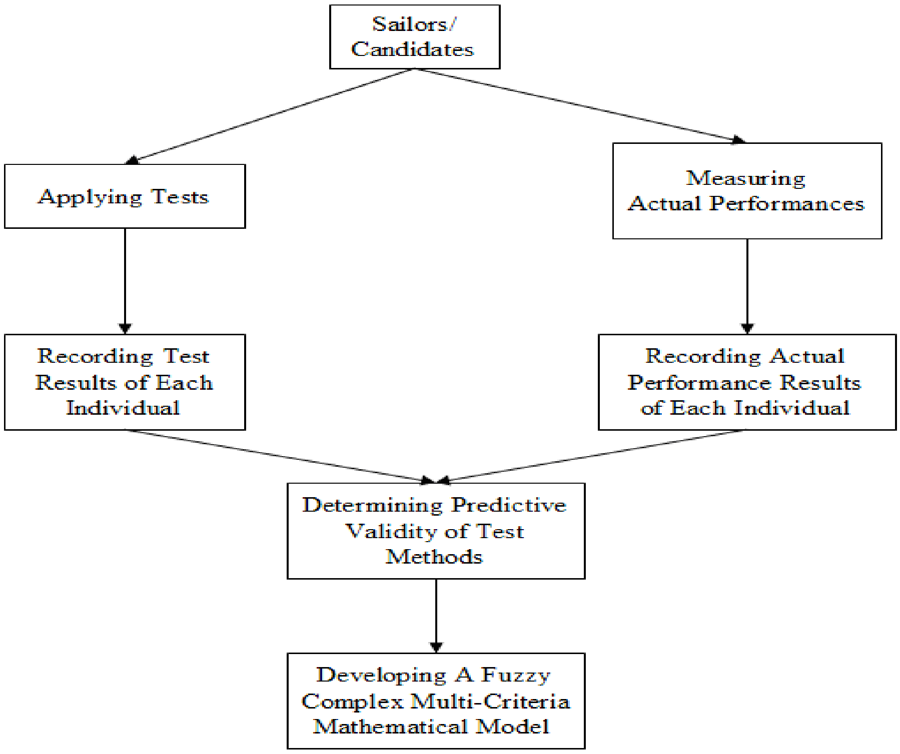

Figure 2. Detailed Phase 3.

3. CONCLUSION AND DISCUSSION

Over the last decades, the amount of recruitment research and the variety of topics addressed has increased substantially. Numerous meta-analytic studies on skills/abilities – job performance relations have demonstrated that personality related measures and measurement of correct skills and abilities may significantly contribute to the prediction of job performance criteria and if used appropriately, may add value to personnel selection practices. Choice of a comprehensive and appropriate list of skills and abilities for use in predicting job performance should be based on careful consideration of the expected theoretical or conceptual relations link to performance criterion of interest, as well as the appropriate level of analysis between predictor and criterion measures.

Different individuals possess a variety of skills, abilities and personal characteristics that might be useful in predicting who will be best suited for different types of maritime jobs or duties. The ultimate objective of this paper is to determine these skills and abilities by developing a profile of successful sailors to be used in the selection procedures to be used by maritime HR managers. Issues on human resources such as quality and competency of crew, as well as crew performance can be considered critical human resource qualifications for maritime companies. Among all the sub-functions of human resource management, personnel selection and placement considerably influences all of those issues regarding crew on board and thus it has been one of the most important topics in maritime HRM, as well as in general HRM literature [11].

Several studies have been conducted to help maritime organizations make effective personnel selection decisions. The personnel selection process generally deals with critical, yet complex issues. For instance, since all personnel attributes/characteristics are not equally important, thus properly setting the importance weights of different criteria to reflect the actual situations is important but so hard. Aggregating the measurement results and then ranking the applicants is another difficult area. Hence, significance and complication of the personnel selection process require effective analytical and holistic methods to provide a decision framework.

This paper mainly concentrates on proposing an integrated, sound and comprehensive process following a holistic approach for personnel selection and placement of maritime companies. Proposed three-phase skill and ability based personnel selection and placement process will provide an effective way and help the maritime companies in selecting the right person and placing him/her to the right job. The proposed model is designed to increase the effectiveness and efficiency of the selection procedure, and determines that incumbents have the necessary skills and abilities to handle the technical aspects of maritime training and job performance on board. Eventually our aim is to propose a more effective suitability profile, by combining the process with a fuzzy complex multi-criteria mathematical model for better decision making. Hence, the objective is to increase the efficiency of the maritime human resource pipeline and reduce the burden of unproductive job performance by providing an opportunity for early detection of candidates who are and are not likely to perform satisfactorily as sailors.

The further research direction can be shifted to the performing of the proposed model under fuzzy environment to manage the impairment of decision-makers especially on qualitative assessment criteria as well. Future studies may also include comparing previous models with the one proposed in this study.

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RESEARCH ARTICLE

PATTERN RECOGNITION FROM FACE IMAGES

Tolga ENSARİ [1]

[1] Computer Engineering, Istanbul University, Istanbul, Turkey
ensari@istanbul.edu.tr

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ABSTRACT

In this article, we use projected gradient descent nonnegative matrix factorization (NMF-PGD) method and make pattern recognition analysis on ORL face data set. Face recognition is one of the critical issues in our life and some security, daily activities and operations use this well known application area. NMF-PGD is a type of nonnegative matrix factorization (NMF) which defined in the literature. In the study, derived NMF-PGD definition and algorithm has been used in order to classify the ORL face images. We give the experimental results in a table and graph. According to experiments, face recognition accuracy rates have different accuracy values because of the k - lower rank value. We change k-values between 25 and 144 to see the performance of NMF-PGD. At the end, we make some analysis and comments on the recognition rates. Additionally, NMF-PGD can also be used for different kind of pattern recognition problems.

Keywords: *Pattern Recognition, Classification, Face Recognition, Nonnegative Matrix Factorization.*

ÖZ

Bu makalede, iz düşüm eğimli azatlım negatif olmayan matris ayrıştırma (NMF-PGD) yöntemi kullanılmış ve ORL yüz veri kümesi üzerinde örüntü tanıma analizleri yapılmıştır. Yüz tanıma, güvenlik ve günlük aktivitelerde kullandığımız hayatımızdaki önemli ve iyi bilinen alanlardan bir tanesidir. NMF-PGD, literatürde tanımlanmış bir negatif olmayan matris ayrıştırma yöntemidir. Bu çalışmada, elde edilmiş NMF-PGD tanımı ve algoritması, ORL yüz veri imgelerini sınıflandırmak için kullanılmıştır. Deneysel analiz ve sonuçlar tablo ve grafik halinde sunulmuştur. Deneysel sonuçlara göre, yüz tanıma doğruluk oranları k-düşük rank değeri nedeniyle farklı değerlere sahip olmaktadır. k-düşük rank değerlerini 25 ve 144 arasında olacak şekilde değiştirip seçerek, NMF-PGD yönteminin performansını test ettik. Son kısımda, bu oranlar hakkında çeşitli analizler ve yorumlarda bulunduk. Ek olarak, NMF-PGD diğer çeşitli örüntü tanıma problemlerinde de kullanılabilir.

Anahtar Kelimeler: *Örüntü Tanıma, Sınıflandırma, Yüz Tanıma, Negatif Olmayan Matris Ayrıştırma.*

1. INTRODUCTION

Nonnegative matrix factorization (NMF) is a well known and popular algorithm in pattern recognition. It is one of the machine learning algorithms, which has many application areas. NMF has been introduced by Lee and Seung in the literature [6, 7]. The authors define this method as part learning approach, because of its learning approach. There are many NMF derived type of algorithms and applications published in the literature [1-5, 8, 9-13]. Especially, image and signal processing, bioinformatics, robotics, finance and other application areas are popular for NMF. There are several studies published in these issues [1-7, 9-13]. Among pattern recognition methods, it is one of the unsupervised learning based type method [8]. k-lower rank values can be defined k-cluster values. Using different values and objective functions affects the performance of NMF and other derived NMF methods. Related studies in the literature are being published in these years. For example, face recognition, voice recognition, microarray data classification, some churn analysis are some of them.

2. PROJECTED GRADIENT DESCENT NONNEGATIVE MATRIX FACTORIZATION (NMF-PGD)

In this article, we use NMF-PGD for ORL face data set and get recognition results for face images. Firstly, we give a definition of Nonnegative matrix factorization (NMF). NMF proposed by Lee and Seung in 1999. It can be defined approximation between *A* matrix and products of *W* and H matrices. The authors use multiplicative update rule in their publication and show efficiency and derivation of this algorithm. They prove that NMF especially gives better accuracy results for part based learning [2, 3, 6, 7].

In NMF structure, *A* is called nonnegative data matrix, *W* and *H* are called lower rank matrix representations. Let *A* matrix has *m x n* dimension. We can define the rank of *A* as $k \leq min\ (m, n)$. Therefore in this condition, *m x k* and *k x n* are the dimensions of *W* and *H* matrices', respectively. The factorization process of NMF can be calculated with Eq (1).

$$A \approx W \cdot H \qquad (1)$$
$$\text{subject to } W \geq 0 \text{ and } H \geq 0$$

Here, we define Obj(A, WH) as an objective function (calculation of error). We optimize and make it smaller in order to get good factorization of the matrices. In the literature, authors generally use Euclidean, Kullback-Leibler divergence and Itakura-Saito divergence as an objective function. Proposed different kind of objective functions has a good accuracy rates on different kind of several NMF studies. Projected gradient descent NMF (NMF-PGD) is also a kind of NMF which derived from NMF algorithm with projected descent approach. Lee and Seung use multiplicative update algorithm and we can state it below [6, 7].

$$H_j^{k+1} = H_{bj}^{k} \frac{((W^k)^T A)_j}{((W^k)^T W^k H^k)_j}, \quad \forall j.$$

$$W_i^{k+1} = W_i^{k} \frac{(A\,(H^{k+1})^T)_i}{(W^k H^{k+1} (H^{k+1})^T)_i}, \quad \forall i.$$

Multiplicative algorithm and also its stability and analysis have been proved analytically in the literature. Analysis shows its efficiency and mathematical background of derivations.

3. EXPERIMENTAL RESULTS

There are 400 faces in ORL face data set and we use them for NMF- PGD (Figure 1.). Accuracy metric with error analysis has been made. We change k-lower rank value from 25 to 144 basis images and we give recognition accuracy results in terms of accuracy for each k-value. We use k-nearest neighbor to classify faces after NMF-PGD algorithm. Classification results have been illustrated in Table 1 and Figure 2. We test NMF-PGD method running it one time.

Figure 1. ORL face data set sample images

We divide the data asset for training and testing phases. These images (faces) can be seen from Figure 1.

Table 1. Classification accuracy rates according to k-values for ORL face data set

Method	Accuracy with k-values (%)							
	k=25	k=36	k=49	k=64	k=81	k=100	k=121	k=144
NMF-PGD	77,3	78,1	79,8	78,9	80,3	82,4	83,3	82,8

After experimental analysis, we show that when we increase the k-lower rank value, then recognition rate accuracy also increases. But it is not general rule for other NMF based approach. Even for other applications it can be different. NMF-PGD reaches 83,3 % as the highest accuracy value when k-lower rank value is 121.

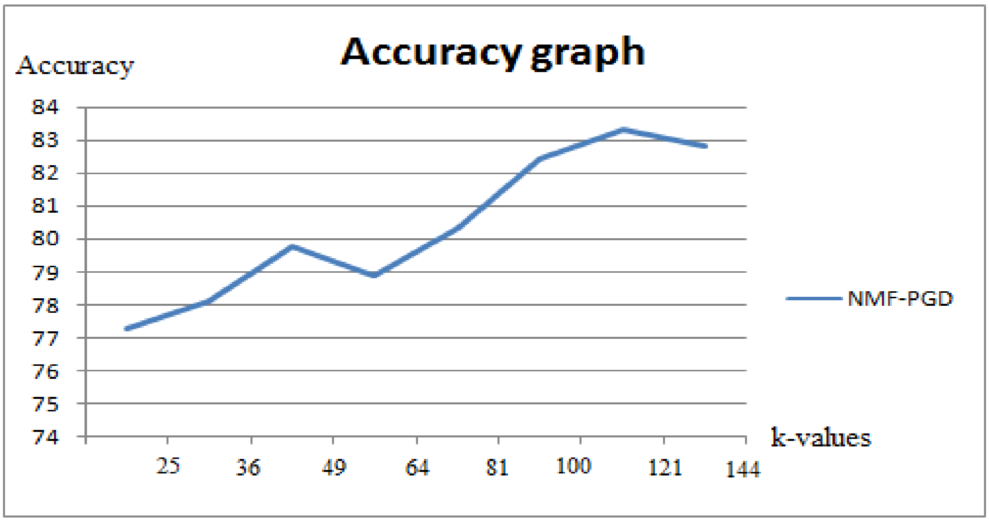

Figure 2. Classification accuracy rates graph according to k-values

The graph illustrated in Figure 2 for different k-lower rank values. These rates can be seen from Figure 2 for NMF-PGD method.

4. CONCLUSION

In this study, we use NMF-PGD for face recognition application area. ORL face data set has been chosen for the experimental analysis. We analyze patterns in faces with NMF-PGD and calculate their accuracy rates for each k-lower rank value. When k-lower rank value changes, the recognition accuracy also changes. NMF-PGD is derived from NMF and uses its approach into pattern recognition and part based learning. We show accuracy values of ORL face data set using NMF-PGD. The figures and the table illustrate our applications and recognition rates. Different kind of NMF algorithms and different kind of application areas can be tested in this context for future studies.

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RESEARCH ARTICLE

THE COMPARISON OF HYPOTHESIS TESTS DETERMINING NORMALITY AND SIMILARITY OF SAMPLES

Levent ŞAHİNTÜRK [1]
Burcu ÖZCAN [2]

[1] *Department of Industrial Engineering, Kocaeli University, Umuttepe, Kocaeli, Turkey, sahinturk.l5841@gmail.com*
[2] *Department of Industrial Engineering, Kocaeli University, Umuttepe, Kocaeli, Turkey, burcu.ozcan@kocaeli.edu.tr*

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ABSTRACT

A number of hypothesis tests are used to obtain information about the characteristics of one or more populations. While parametric tests are based on the assumption of normal distribution, non-parametric tests are performed with highly ordered series from the original series. The main purpose of this study is to check whether two independent samples taken from two different populations of normally distributed samples fit the normal distribution with Kolmogorov-Smirnov and Shapiro-Wilk tests. And to determine the similarities of Kolmogorov-Smirnov and Sign test to samples with normal distribution by Wilcoxon test and those with non-normal distribution. As a result, it is aimed to compare the strength and effectiveness of the applied tests. We used the MATLAB function in our work which is considered to be useful for researchers.

Keywords: *Parametric Tests, Non-parametric Tests, Kolmogorov-Smirnov, Shapiro-Wilk, Wilcoxon, Sign Tests.*

ÖZ

Bir ya da daha fazla yığının karakteristikleri hakkında bilgi edinmek için bir takım hipotez testleri kullanılır. Parametrik testler normal dağılım varsayımı üzerine kurulu iken, parametrik olmayan testler orijinal serilerden ziyade yüksek dereceli serilerle gerçekleştirilir. Bu çalışmanın temel amacı normal dağılımlı iki yığından alınan iki bağımsız örneğin Kolmogorov Smirnov ve Shapiro Wilk testleriyle normal dağılıma uyup uymadığının kontrol edilmesidir. Test sonucunda normal dağılıma uygun olan örneklerin Wilcoxon testi ile normal dağılıma uymayan örneklerin ise Kolmogorov Smirnov ve İşaret testi ile benzerliklerinin belirlenmesi sağlanır. Sonuç olarak uygulanan testlerin güç ve etkinliğinin karşılaştırılması hedeflenmiştir. Araştırmacılar için yararlı olduğu düşünülen çalışmamızda MATLAB fonksiyonunu kullandık.

Anahtar Kelimeler: *Parametrik Olmayan Testler, Parametrik Testler, Kolmogorov-Smirnov, Shapiro-Wilk, Wilcoxon, İşaret Testi.*

1. INTRODUCTION

Hypothesis tests are tests that investigate whether the difference between a sample and the mean of the population in which the sample is drawn is significant. If we are interested in the difference between the averages of the two populations; we can see if the difference is correct by testing hypotheses on the difference between the averages of the samples taken from them [1].

Before performing statistical analysis, it should be checked whether the data are categorical or continuous. While non-parametric statistics are used in categorical data (sex, color, marital status), parametric statistics are used in continuous data.

Many of the traditional tests are based on the assumptions of descriptive statistical classes in the examples, also called parameters. These tests are also called parametric tests [2]. It is known that the results obtained when the parametric tests are based on the assumption of normal distribution and on abnormal distributions are not reliable [3]. If the sample size is large, deviation in the normal distribution may not significantly affect the reliability of the parametric tests (Central Limit Theorem). Non-parametric tests are done with highly ordered series from the original series. For this reason they are not affected by excessive values.

One of the assumptions of parametric tests is that the distributions of the populations in which the samples are selected are normal. When parametric tests are used, it must be ensured that this assumption about the distributions of the population is satisfied. For this reason, a number of tests are carried out for the suitability of normal distribution of selected samples. The purpose of these tests is to decide whether the sample data conforms to the predicted distribution. Goodness of fit tests can also be called for these types of tests [5].

The purpose of this study is to determine normality and similarity of the samples. Kolmogorov-Smirnov and Shapiro-Wilk tests will be used to determine normality. In the second part of our study, we will try to determine similarities of the groups of samples drawn from the populations. If both samples are normal, Wilcoxon test will be applied to parametric tests. If normal distribution is not appropriate for any of the sample groups, Kolmogorov-Smirnov and sign test will be applied for non-parametric tests. Tests related to position can also be called for these tests [5]. All tests will be carried out on different sized specimens randomly generated and taken from populations meeting normal dispersion.

2. GOODNESS OF FIT TESTS

Goodness of fit tests are used to determine whether the distribution of observational values in the samples conforms to a particular theoretical or experimental population distribution. The researcher who tests the goodness of fit wants to prove that he does not come normally. On the other hand, in the majority of other statistical tests it is hoped that the investigator rejects the null hypothesis, that is to say that one or more of the samples does not come from a particular kit or the same kit. It should also be noted that, if the null hypothesis is rejected, the alternative hypothesis for the goodness of fit does not predict a more suitable distribution for data [6]. Two normality tests used in the study are described in detail below.

2.1. Shapiro-Wilk Test

One of the tests that can be used for normality is the Shapiro-Wilk test. Generally, less than 50 observations do not yield correct results for the values [7]. Hypotheses for this test;

H_0: *F(x)* is a normal distribution function whose mean and variance are unknown.

H_1: *F(x)* isn't a normal distribution function whose mean and variance are unknown.

Let *n* be a random sample of size $X_1, X_2, X_3 ..... X_n$. For this random sample, the sequential statistics are $X_{(1)}, X_{(2)}, X_{(3)} ..... X_{(n)}$. The sum of the squares of the differences between the measured values and the arithmetic mean is denoted by *D*.

$$D = \sum_{i=1}^{n} (X_i - \overline{X})^2 \tag{2.1}$$

If the data is converted to frequency distribution;

$$D = \sum (X_i - \overline{X})^2 f_j \quad , \quad \overline{X} = \frac{\sum X_j f_j}{n} \tag{2.2}$$

formulas are used.

The $a_1, a_2, a_3 ..... a_k$ constants are found in the a_1 coefficient table for the Shapiro-Wilk test with $k = n / 2$ and the Shapiro-Wilk statistic indicated by *W* is defined as follows;

$$W = \frac{1}{D}\left[\sum_{i=1}^{k} ai(X_{(n-i+1)} - X_{(i)})\right]^2 \tag{2.3}$$

In the Shapiro-Wilk test for normality, the value calculated for the W stat is determined by the value of $P(W < W_h)$. If $P(W < W_h) < \alpha$, the H_0 hypothesis is rejected.

2.2. Kolmogorov-Smirnov Test

Kolmogorov-Smirnov is a compliance test that can be applied to continuous therapy. In a group, the Kolmogorov-Smirnov goodness-of-fit test is used to determine how well a random sample of a given distribution (flat, normal, or poisson) Using the test, it can be determined whether a series is normally distributed [3].

The distributions suggested in the Kolmogorov-Smirnov test hypothesis are made by comparison of the sample cumulative distribution function. A cumulative distribution function is defined by the following equation.

$$F(x) = P\,(x\ \leq k) \tag{2.4}$$

The solved values of this function provide the following relation for the cumulative binomial and poisson distributions.

$$P\,(x\ \leq k) = \sum_{i=1}^{k} P\,(x) \tag{2.5}$$

When a random sample of n volume with a cumulative distribution function unknown is selected, this data consists of independent observation results such as x_1, x_2, x_3..... x_n. $F_0\,(x)$ is the cumulative distribution function of the distribution given in the hypothesis, whereas the null hypothesis and the opposite hypothesis are as follows.

H_0: $F(x) = F_0\,(x)$, for all x values

H_1: $F(x) \neq F_0\,(x)$, for at least one x value

The observed cumulative distribution function $S(x)$ is the ratio of the number of sample units with values equal to or less than x to the sample volume of the number. So;

$$S(x) = \frac{The\ number\ of\ sample\ units\ with\ values\ less\ than\ or\ equal\ to\ x}{n} \tag{2.6}$$

The D statistic value is the largest vertical length between $F_0\,(x)$ and $S(x)$. $S(x)$ is discrete when $F_0\,(x)$ is continuous. For this reason, for a selected sample, there are two different results for $|S(x)- F_0 (x)|$ at the two ends of any range that *X* does not value. Because of this feature, the value of the Kolmogorov-Smirnov statistic is calculated by the following formula when $F_0 (x)$ is continuous and *S(x)* is intermittent;

$$D = TheBiggest\ \{\square|S(xi) - F0\,(xi)|\,, |S(xi-1) - F0\,(xi)|\ \} \tag{2.7}$$

The value calculated by this method is called the corrected value of the D statistic. If Kolmogorov-Smirnov statistic is discrete at $F_0 (x)$ then *D* calculated by;

$$D = TheBiggest\ |S(xi) - F0\ (xi)| \tag{2.8}$$

3. SIMILARITY TESTS FOR TWO SAMPLE GROUPS

Even if one of the two independent samples does not come from the normal distribution and if the small volume samples are used, the use of the parametric tests is not correct. And also even if one of the samples does not come from a normal distribution and the sample volumes are not large enough, non-parametric tests should be preferred instead of parametric tests. In this section, the Wilcoxon for the equality hypothesis of the positional parameters of the population positions of two dependent samples and the Kolmogorov-Smirnov test for the equality hypothesis of the position parameters of the heights of the two independent samples of the mark test are introduced.

3.1. Wilcoxon Signed-Rank Test

When testing hypotheses in two sample problems, the Wilcoxon rank-sum test is often used to test the position parameter, and this test has been discussed by many authors over the years [14]. A nonparametric test used to determine whether two interdependent samples taken from the population show the same distribution.

H_0: Equal test results. The sum of positive and negative differences between test results is equal to each other.

H_1: Peer trial results are not equal to each other. The sum of negative differences is too small or too large compared to the sum of positive differences.

Differences between peer trial results are determined algebraically. We then take the absolute values of these differences and rank them either from the smallest to the largest or from the largest to the smallest, always taking note of the ranks of the absolute values with positive differences and those with negative differences [15]. The probability and importance of observing the *T* statistic is determined. The probability of observing *T* is determined in two ways, depending on the number of units [9].

i. If the unit number is $6 \leq n \leq 25$, the Wilcoxon *T* criterion table is used. The significance of *T* is determined by considering these T_α critical values.

ii. If n>25, the probability of observing *T* and the significance of *T* are determined by taking advantage of the assumption that *T* statistic shows normal distribution with μT and $\sigma^2 T$ parameters.

$$\mu T = \frac{n(n+1)}{4} \quad ; \qquad \sigma T = \sqrt{\frac{n(n+1)(2n+1)}{24}} \quad ; \qquad Z = \frac{T - \mu T}{\sigma T} \tag{3.1}$$

As a result, the test statistic is calculated by the following formula.

$$Z = \frac{T - \frac{n(n+1)}{4}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}} \tag{3.2}$$

3.2. Sign Test

The sign test is used to test whether the distribution of sample values is random. By using the median values in the application of the test, the sample values are divided into large and small according to the media. The sign test is designed to test the hypothesis about the central location of the population distribution [4].

For two dependent samples, the sign test requires defining a new variable from the X and Y variables. As $D_i = X_i - Y_i$; $i = 1, 2, 3,......,n$ we define this new variant as D;

$$\delta i = \begin{cases} 1, & Di > 0 \\ 0, & Di < 0 \end{cases} \quad \text{to be} \quad k = \sum_{i=1}^{n} \delta i \tag{3.3}$$

is formulated.

While the null hypothesis is correct, this statistic has binomial distribution. In other words;

$$f(k) = \binom{n}{k}\left(\frac{1}{2}\right)^{k}\left(\frac{1}{2}\right)^{n-k} = \binom{n}{k}\left(\frac{1}{2}\right)^{n} \quad ; k = 0, 1, 2, 3, ..., n \tag{3.4}$$

The hypothesis of absence in the sign test for two dependent samples;

H_0: D_i The median of the population of differences is zero is expressed. The decision rule for the different cases of the H_1 hypothesis with the value calculated for the K statistic being k_h can be expressed as follows.

H_1	Decision Rule	
D_i the median of differences population is less than zero	$k_h \leq k_\alpha$	H_0 is rejected.
D_i the median of differences population is greater than zero	$k_h \geq k'_\alpha$	H_0 is rejected.
D_i the median of differences population different from zero	$k_h \leq k_{\alpha/2}$ or $k_h \geq k'_{\alpha/2}$	H_0 is rejected.

k_α , k'_α , $k_{\alpha/2}$ ve $k'_{\alpha/2}$ are critical values. It is found as follows;

$P(k_h \leq k_\alpha) = \alpha$ $\quad$ $P(k_h \geq k'_\alpha) = \alpha$

$P(k_h \leq k_{\alpha/2}) = \alpha/2$ $\quad$ $P(k_h \geq k'_{\alpha/2}) = \alpha/2$

3.3. Kolmogorov-Smirnov Test

Two independent samples of volume n1 and n2 are represented by X_1, X_2, X_3..... X_{n1} and Y_1, Y_2, Y_3..... Y_{n2} . To determine if two samples come from the same stack;

$F_1\ (x)$: Unknown distribution function of the population on which the first sample arrives

$F_2\ (x)$: Unknown distribution function of the population on which the second sample arrives

H_0: $F_1\ (x) = F_2\ (x)$, for all x values

H_1: $F_1\ (x) \neq F_2\ (x)$, below are the definitions for obtaining the Kolmogorov-Smirnov test statistic for at least one x value;

$S_1\ (x)$: The observed distribution function for the first group of sample

$S_2\ (x)$: The observed distribution function for the first group of sample

$$S1\,(x) = \frac{\begin{matrix}\mathit{In\ the\ first\ example, the\ number\ of\ sample} \\ \mathit{units\ with\ values\ less\ than\ or\ equal\ to\ x}\end{matrix}}{n1} \tag{3.5}$$

$$S2\,(x) = \frac{\begin{matrix}\mathit{In\ the\ second\ example, the\ number\ of\ sample} \\ \mathit{units\ with\ values\ less\ than\ or\ equal\ to\ x}\end{matrix}}{n2} \tag{3.6}$$

For the two-sided test, the test statistic is defined as follows;

$$D = TheBiggest\ |S1(x) - S2\,(x)| \tag{3.7}$$

If the null hypothesis is true (if two samples are selected from similar populations) $S_1\ (x)$ and $S_2\ (x)$ show a close approximation for all observation values. If the value of the D statistic is zero or as small as possible this will support the null hypothesis.

4. NORMALITY TESTS

In the first part of our studies, randomly produced different size populations are used. We will determine by Kolmogorov-Smirnov and Shapiro-Wilk tests whether the two groups of different sizes samples taken from the normal distribution populations. Matlab's Statistical Tools are used for these tests.

"*X = mvnrnd(meanX, varX, N)*" matlab function is used for randomly generated populations. In this function, we need to specify the average, variance and the size of the populations. Two different groups of samples are randomly selected with the Matlab function *"randperm (N)"* from the different sized populations with the selected normal distribution.

"*[hypResult, pValue, testStats, approxCritVal] = kstest(X_normed)*" matlab function is the Kolmogorov-Smirnov test that tests for normal dispersion. Since the Matlab statistical tool that performs the Shapiro Wilks test is paid, this function is used as open source code via internet.

4.1. First Computation Results

The following graphs can be used to examine the information of two randomly generated samples with average of *(μX)* 90, variance of ($\sigma^2 X$) 30 and the size of 10000 randomly selected population of 1000 samples.

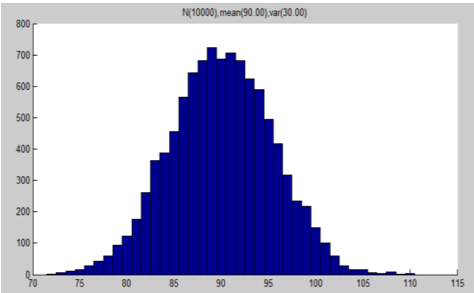

Figure 1. Randomly generated population

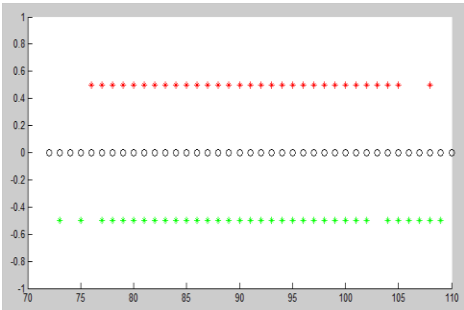

Figure 2. Two samples

Figure 1 shows the graph of the population, characteristics given above and Figure 2 shows the first group of samples randomly drawn from population in red plus sign (upper side) and the second group of samples in green plus sign (bottom side).

The test statistic values are 0.05019 and 0.046384 when tested with Kolmogorov-Smirnov where two groups of samples have normal distribution. If the same test is performed with Shapiro-Wilk, the test statistic values are found to be 0.005677 and 0.0008442, which is also normal distribution.

4.2. Second Computation Results

The following graphs can be used to examine the information of two randomly generated samples with average of (μX) 90, variance of ($\sigma^2 X$) 30 and the size of 1000 randomly selected population of 500 samples.

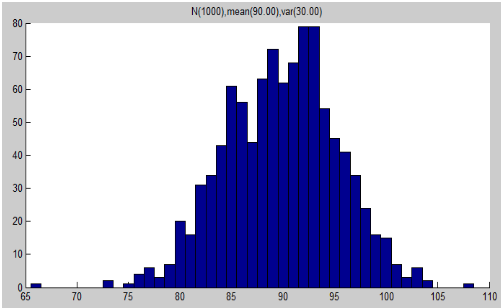

Figure 3. Randomly generated population

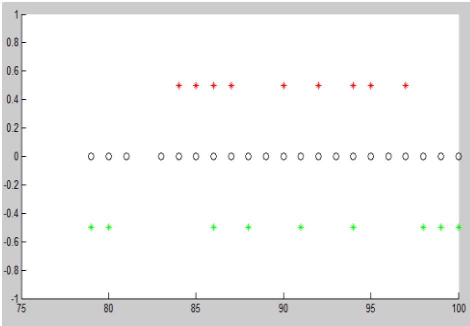

Figure 4. Two groups of samples

Figure 3 shows the graph of the population, characteristics given above and Figure 4 shows the first group of samples randomly drawn from population in red plus sign (upper side) and the second group of samples in green plus sign (bottom side).

The test statistic values are 0.066488 and 0.052887 when tested with Kolmogorov-Smirnov where two groups of samples have not normal distribution. If the same test is performed with Shapiro-Wilk, the test statistic values are found to be 0.00034782 and 0.03019 which is normal distribution.

5. SIMILARITY TESTS OF SAMPLE GROUPS

As a result of the tests performed in the fourth chapter, the similarity of Wilcoxon test for the groups with normal distribution also Kolmogorov-Smirnov and Mark test for the groups without normal distribution were investigated. The following Matlab Functions have been used to identify the similarities of sample groups;

Wilcoxon test *[wilc.p,wilc.h]= ranksum(A,B),*
Sign test *[signTest.p, signTest.h, signTest.stats] = signtest(A,B)*
Kolmogorov-Smirnov *[kolmog2.h, kolmog2.p, kolmog2.t] = kstest2(A,B)*

The tests were carried out on sample groups of 5, 15, 25, 100 and 1000 observations from 100, 1000 and 10000 data sets. The largest and smallest observation values are limited to 30 variances. The test result is shown below. Accordingly, the following table shows the size of the population used in the tests, the size of the sample taken from the population, the limits of the observation values, whether the groups are similar to normal distribution, and whether they are similar or not according to whether they are normal or not.

Let's explain the line of table that population size is 100 and sample size is 25. The observations of sample change from 69 to 109 because of the variance. It was observed that 25 observations in both groups had non-uniform distribution which tested by Kolmogorov-Smirnov. The similarity of the 9% with the Wilcoxon test was found to be similar to the groups twice. It is found similar 2 times by the test of Kolmogorov-Smirnov and their positions in the row (rng 8996, rng 2760) were found. It was also observed that 91% of the samples were similar to the Signal test and their location (rng 4208) was determined.

If we were to examine for a different value, let's expose the line with a table size of 10000 and a sample size of 1000. Because the variance is 30, sample observations range from 65 to 115. With the Kolmogorov-Smirnov test, 8% of group A and 12% of group B were observed to have unusual distribution for 1000 observations in both groups, whereas the normal distribution of the whole was observed by Shapiro-Wilks test. The similarity of the 97% portion with the Wilcoxon test was tested and found to be similar to the groups 3 times and found in their positions (rng 9616, rng 7808 and rng 8371).

Table 1. List of A and B group observation values in normal distribution and unavailability of both groups

Population Size	Sample Size	Min. Observation	Max. Observation	Kolmogorov-Smirnov Test				Shapiro-Wilks Test				Wilcoxon Test		Kolmogorov-Sim.		Sign Test	
				Non-Normal Dist.		Normal Distribution		Non-Normal Dist.		Normal Distribution		Non Similar Samples	Similar Samples	Non Similar Samples	Similar Samples	Non Similar Samples	Similar Samples
				Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B						
100	5	67	111	100	100	0	0	93	93	7	7	0	0	96	4	100	0
100	15	70	114	100	100	0	0	93	93	7	7	0	0	100	0	97	3
100	25	69	109	100	100	0	0	91	91	9	9	2	0	98	2	99	1
100	100	69	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	1000	69	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	5	64	114	100	100	0	0	96	96	4	4	0	0	94	6	100	0
1000	15	66	113	100	100	0	0	94	94	6	6	0	0	99	1	98	2
1000	25	66	116	100	100	0	0	98	98	2	2	0	0	98	2	99	1
1000	100	66	114	99	100	1	0	93	93	7	7	0	0	98	2	95	5
1000	1000	66	114	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10000	5	63	116	100	100	0	0	93	93	7	7	2	0	93	7	100	0
10000	15	64	117	100	100	0	0	91	91	9	9	0	0	97	3	99	1
10000	25	64	117	100	100	0	0	95	95	5	5	0	0	97	3	99	1
10000	100	65	116	100	100	0	0	91	91	9	9	1	0	98	2	97	3
10000	1000	65	115	8	12	92	88	0	0	100	100	97	3	0	0	0	0

Parametric/Non-Paramateric Test and Size of Population	Sample Size	Where in Sample	Avarage	Variance
Non-parametric Klmogorov2 Test succeded for N(100)	n_a(5)	rng(9532)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(100)	n_a(5)	rng(1728)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(100)	n_a(5)	rng(1834)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(100)	n_a(5)	rng(6093)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(100)	n_a(15)	rng(202)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(100)	n_a(15)	rng(6626)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(100)	n_a(15)	rng(1908)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(100)	n_a(25)	rng(4208)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(100)	n_a(25)	rng(8996)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(100)	n_a(25)	rng(2760)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(5)	rng(9786)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(5)	rng(6151)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(5)	rng(4923)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(5)	rng(7690)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(5)	rng(4093)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(5)	rng(9562)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(15)	rng(4525)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(15)	rng(1287)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(15)	rng(9046)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(25)	rng(1297)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(25)	rng(588)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(25)	rng(1811)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(100)	rng(3629)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(100)	rng(3629)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(100)	rng(193)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(1000)	n_a(100)	rng(2429)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(100)	rng(2743)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(100)	rng(4841)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(1000)	n_a(100)	rng(3453)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(423)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(6955)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(3868)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(4541)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(3514)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(2656)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(5)	rng(3168)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(15)	rng(7372)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(15)	rng(7793)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(10000)	n_a(15)	rng(7793)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(15)	rng(6597)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(25)	rng(6963)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(25)	rng(5011)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(10000)	n_a(25)	rng(8410)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(25)	rng(8420)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(100)	rng(3197)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(10000)	n_a(100)	rng(3197)	meanX(90)	varX(30)
Non-parametric Klmogorov2 Test succeded for N(10000)	n_a(100)	rng(8896)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(10000)	n_a(100)	rng(3817)	meanX(90)	varX(30)
Non-parametric Sign Test succeded for N(10000)	n_a(100)	rng(2408)	meanX(90)	varX(30)
Parametric Wilcoxon Test succeded for N(10000)	n_a(1000)	rng(9616)	meanX(90)	varX(30)
Parametric Wilcoxon Test succeded for N(10000)	n_a(1000)	rng(7808)	meanX(90)	varX(30)
Parametric Wilcoxon Test succeded for N(10000)	n_a(1000)	rng(8371)	meanX(90)	varX(30)

6. CONCLUSION

In general, the Shapiro-Wilk test is more robust than the Kolmogorov-Smirnov test for all distributions and sample sizes among the two tests considered for normality tests. However it can be said that the Shapiro-Wilk test is better than the Kolmogorov-Smirnov test for small sample size.

While parametric statistical techniques are commonly used with ratio data, nonparametric statistical techniques use nominal and rank order data [11]. That is, nonparametric tests are the ones that have the power of the sequence numbers as well as naturally analyze the interspersed data. That is, the researcher can say that only one of them has more or less features than the other, how much or less he can not say.

Table 2. Use of statistical methods according to years

Statistical Methods	1978–1979	1989	2004-2005
t-tests (one-sample, two-sample, and matched-pair)	44%	39%	26%
Non-parametric tests (Wilcoxon-Mann-Whitney, sign, and Wilcoxon signed rank sum)	11%	21%	27%

And also, it was also observed in the study that the normal distribution within random samples taken from a suitable population of normal distributions is difficult to find a suitable sample.

Errors in reaching conclusions or decisions lead to adverse effects on the reliability, validity and validity of the results. Failure to use these statistical tests, failures to comply with multiple comparisons, failure to identify and explain the statistical test used, and failure to estimate sample size [11].

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RESEARCH ARTICLE

INVESTIGATING THE EFFECT OF 5S APPLICATIONS ON BUSINESS EXCELLENCE: A SAMPLE IN TURKISH FOOD INDUSTRY

Hakan DEMİR [1]
Mehmet Bilge Kağan ÖNAÇAN [2]
Ahmet DURMAZ [3]
Mehmet YÜKSEL [4]

[1] *Turkish Navy, Pendik, Istanbul, Turkey, hkn_dmr_87@hotmail.com*
[2] *Barbaros Naval Sciences and Engineering Institute, National Defense University, Tuzla, Istanbul, Turkey, konacan@dho.edu.tr*
[3] *Department of Naval Logistics Management, National Defense University, Tuzla, Istanbul, Turkey, adurmaz@dho.edu.tr*
[4] *Department of Naval Logistics Management, National Defense University, Tuzla, Istanbul, Turkey, myuksel@dho.edu.tr*

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ABSTRACT

The main motivation of this research is to examine effects of "5S applications" which is similar to Kaizen philosophy, on excellence perceptions of firms in food sector. In this context, a questionnaire was applied to the logistics department employees of randomly chosen firms that operate in Istanbul and Kocaeli districts. Data obtained from surveys were subjected to structural equation modeling test. According to the results, overall 5S applications showed positive and significant effects on excellence in business variable, excluding "cleaning". Moreover, outstanding effect of "sustain" application is an intriguing finding of this research. With the importance that efficiency concept has today, it is evaluated that the results obtained in this study will be beneficial to organizations, especially during their process improvement activities by being the first research in food sector that seeks connection between the 5S and excellence.

Keywords: *5S Applications, Efficiency, Kaizen, Excellence in Business, Food Sector.*

Hakan DEMİR, Mehmet Bilge Kağan ÖNAÇAN, Ahmet DURMAZ, Mehmet YÜKSEL

ÖZ

Bu araştırmanın temel amacı Kaizen felsefesine benzeyen 5S uygulamalarının gıda sektöründe faaliyet gösteren firmaların mükemmeliyet algılamalarına etkilerini incelemektir. Bu kapsamda, İstanbul ve Kocaeli'nde faaliyet gösteren ve rastgele seçilen firmaların lojistik birimlerinde çalışan personele anket uygulanmış ve anketlerden elde edilen veriler yapısal eşitlik modellemesi ile teste tabi tutulmuştur. Elde edilen sonuçlara göre, "temizlik" hariç tüm 5S uygulamalarının iş mükemmelliği değişkeni üzerinde anlamlı ve belirgin etkileri bulunmaktadır. Ayrıca, araştırmanın önemli bir bulgusu da "sürdürülebilirlik" değişkeninin mükemmelik değişkeni üzerindeki göze çarpan etkisinin tespit edilmiş olmasıdır. Verimlilik kavramının günümüzde sahip olduğu önem nedeniyle, gıda sektöründe 5S ile mükemmellik arasında bağlantı kurmayı amaçlayan ilk araştırma olan bu çalışmada elde edilen sonuçların, işletmelere özellikle süreç iyileştirme faaliyetlerinde fayda sağlayacağı değerlendirilmektedir.

Anahtar Kelimeler: *5S Uygulamaları, Verimlilik, Kaizen, İş Mükemmelliği, Gıda Sektörü.*

1. INTRODUCTION

Increasing competition and rapid changes both in businesses and markets have forced enterprises to adjust their working styles to improve their performance. To confront these competitions and changes, enterprises need appropriate management systems.

Excellence is a combination of values and activities which results in remarkable achievements. In other words, excellence can be defined as quality enhancement. Different business excellence models are applied in many countries to help enterprises to improve their performance [21]. In this context, it is inevitable for excellence to glamour in business. There are myriad of studies on excellent companies and these studies proved the concept of Kaizen (continuous improvement) as a precondition for business excellence [2].

Kaizen is a Japanese word that indicates a process of continuous improvement of the standard way of work [3]. It is a compound word involving “Kai” (change, modify) and “Zen” (for the better). Thus the term of Kaizen means "Continuous Improvement”. Continuous improvement is one of the core strategies for excellence and it is considered vital in today’s competitive business area. It calls for eternal effort for improvement involving everyone in the enterprise [25]. The foundation of Kaizen philosophy is 5S. The five “S” comes from the first letter of the Japanese words (Seiri, Seiton, Seiso, Seiketsu and Shitsuke). The practice of 5S purposes to establish the values of sorting, neatness, cleaning, standardization, and sustain in business [15].

In today's increasingly competitive environment, the foreground of concepts of performance, innovation and excellence lead enterprises to 5S techniques which are applied in the course of Kaizen philosophy. There are some studies about the effects of 5S on performance, innovation and excellence in e-trade workplace [14]; in manufacturing, construction, service, health, education sectors [8] and in sectors which apply total quality management [27]. However, no studies are found in the literature about this area especially in Turkish food sector. In this respect, the basic motivation of the study is to determine the effects of organization, neatness, cleaning, standardization, and sustain elements of the 5S application on the business excellence. The effects of 5S on performance and innovation in Turkish food sector remain as the future works.

This paper has been organized into four sections, starting with the introduction. In literature review section, the concept of 5S is emphasized and detailed, previous studies are mentioned and the benefits of 5S activities are explained. In the third section, the survey data and analyses are presented. In the last section, conclusion, discussion and limitations are given.

2. LITERATURE REVIEW

Excellence is the state or quality of being excel. Particularly in the field of business, excellence is regarded as an important value, and a goal to be chased. Excellence can be defined as the ability of firms to make profits, while meeting the customers’ requirements [9]. According to Contemporary

Turkish Dictionary, excellence is being perfect and completeness. Before 1980's, Total Quality Management that had the same or similar meaning with business excellence was a trend for organizations to improve themselves [11]. Recently, this trend has moved from "quality" towards "excellence," because of the widened focus of the assessment canon [13].

The use of 5S applications for achieving business excellence has been evident in Japan since the World War-II. At first, various plant maintenance concepts were imported to Japan from the US and then, 5S was integrated with Kaizen philosophy by Japanese [14]. The components, namely Seiri, Seiton, Seiso, Seiketsu and Shitsuke, bringing together the concept of 5S, are deeply embedded in Japanese life. For this reason, it is not a randomly formed philosophy, but a system of thought that is influenced by the great influence of Shintoism, Buddhism and Confucianism in Japanese culture. Each component of 5S are explained briefly below [5].

2.1. Seiri (Sorting)

Seiri is about sorting out between necessary and unnecessary materials in the workplace and discard of unnecessary things. The idea of Seiri is to keep only the necessary items in workplace in an appropriate area [12]. According to Kobayashi and friends [14], Seiri creates a system that works effectively and that system presents excellency for enterprises.

2.2. Seiton (Neatness)

Seiton can be defined as "organizing necessary items in excellent in order to pick them up easily for later use". Seiton focuses on where and how much material and equipment should be placed [12]. The essence of seiton is to arrange tools in a sequence of process that relates to the work. A decision must make about the usage rate of materials. Frequently used materials should be placed in easiest access points and rarely used materials should be placed further away. Heights of shelves should be considered, too. Frequently used items can be better at shoulder level, rarely used ones can be better at feet or ceiling level. The reasons behind this are finding equipments easily and much faster, saving time and providing a comfortable location [16].

2.3. Seiso (Cleaning)

Seiso is applied for providing a clean and well-maintained working environment, keeping the equipment clean and protecting them. Purpose of the seiton is to prepare a beautiful work environment by purifying the workplace from the nuts and dust [20]. For this reason, cleanliness can also be expressed as a careful inspection. Seiso (cleaning) looks like the simplest stage of 5S in its name, but it has a complex content that encompasses many activities. Therefore, incomplete and inaccurate actions may create unnecessary costs to enterprises [5].

2.4. Seiketsu (Standardization)

Seiketsu (standardization) is the most important way of ensuring results achieved by sequential and continuous application of the first three principles of 5S. The goal of standardization is to ensure the continuity of a secure, well-organized and lean environment [12]. Seiketsu delineates the worked out and implemented standards in the form of procedures and instructions in workplaces. Standards ought to be communicative, clear and understandable. To provide a true seiketsu standard, it must involve all participants of processes in the given workplace, it means direct workers. With the aim of assuring easy access, compulsory standards should be found in specific and visible places [18].

2.5. Shitsuke (Sustain/Discipline)

Shitsuke is the last S of the 5S system which is interested in the regularity of maintaining the standard of the organization for a set of time [23]. Implementing the idea of the 5S will demand self-discipline connected with implementing and obeying the rules of regularity from employees. It provides an increase in personnel consciousness and a decrease on the number of undesired products and processes [18]. Shitsuke which is an important part of the Kaizen philosophy must be followed and applied continuously because it covers the control and renewal of applications in use [5]. Rains defines the discipline as complying with a set of well thought and defined processes and executing them correctly and he asserts that it’s an essential ingredient to achieve excellence [22].

Some of the benefits of 5S to enterprises are listed below [18, 19].

Seiri : Process improvements, decreases stocks, ease of use at the workplace, prevention of losing equipment.

Seiton : Process improvements, time efficiency, safety improvements.

Seiso : Machine efficiency, maintenance of devices, quick data about damages, improvement of the workplace, elimination of the accidents.

Seiketsu : Increases safety, decreases pollution, process improvements.

Shitsuke : Increasing awareness and morale, decreasing mistakes, decreasing inattention, proceedings according to decisions, improvements in communication.

Gapp et al argue that the 5S applications in business operations will have a positive impact on quality, speed of operation, costs, employee motivation and performance of the company [5]. The concepts like quality, performance, motivation etc. are the key factors of excellence [26]. In this context, it is proposed that 5S applications have positive effect on business excellence consistent with the literature [8, 14, 27].

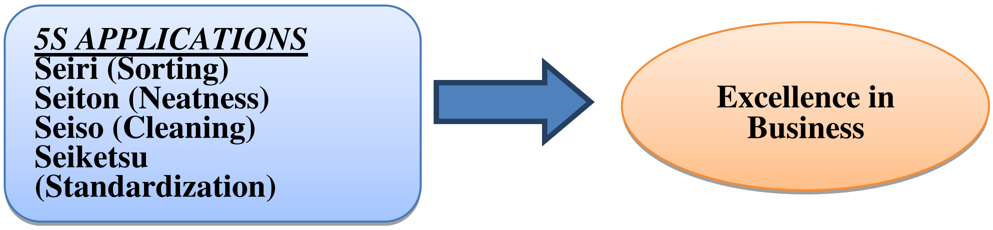

Figure 1. Conceptual Framework

3. METHODOLOGY

This research, which is relational in context according to its aim, consists of three stages. In the first stage, literature had been reviewed about the designated variables and the survey items were prepared. In the second stage research was conducted and data was gathered. In the final stage, data acquired was analyzed and results were expounded.

Target population is composed of logistics department employees of randomly chosen food production facilities operating in Istanbul and

Kocaeli provinces. Due to topic of the research, designated target population were selected from food producing firms. Questionnaires were applied to total 73 employees from 58 firms via face-to-face survey method and data gathered was subjected to analysis. Barclay and his fellow friends assert that for each path directed to a latent variable, ten times observations are needed to reach a significant result [1]. On the other hand, Mertens and friends state that for Partial Least Squares (PLS) algorithm, sample size as small as 30 is adequate for making a coherent assumption [17]. Consequently, 73 observations were determined as sufficient.

In the analysis stage, WarpPls program which can manage small sample sizes was used [7]. Data were subjected to factor analysis, validity and reliability tests and finally structural equation modeling test.

Questionnaire form consists of two parts. First part covers the questions of the constructs presented in this study. In the second part, there are statements aimed to learn demographic and business profile of the respondents. Data was obtained using "5 point-Likert Scale" which is ranging from, "1-strongly disagree to 5-strongly agree". Scales utilized in this study as dependent variable is adapted from Sharma et al. [24]. "5S applications" which is also the independent variable of this study was developed by researchers.

3.1. Characteristics of Sample

The characteristics of the sample are given in Table 1. 67% of the participants were male and 49% of them are aging between 26 and 46 years. As for the educational level of the respondents, majority are university graduates. Participants of this study are generally (86%) enrolled from firms that employ more than 50 personnel. Moreover, majority of the sample works in an experienced organization which has operated for more than six years.

Table 1. Characteristic of Sample

	Frequency	***Percentage***
Gender		
Male	49	67
Female	24	33
Education		
Bachelor’s Degree	52	71
Master’s Degree and Upper	21	29
Age		
18-25	12	17
26-35	36	49
36-45	20	27
46+	5	7
Number of employee in firm		
1-9	3	4
10-49	7	10
50-249	42	57
250+	21	29
Duration of the firm in market (in years)		
Less than 1	2	3
1-5	9	12
6-10	23	32
11-15	22	30
16+	17	23
Total	**73**	**100**

3.2. Reliability and Validity

Assessment of models involves determining the indicator reliabilities, (cronbach alpha, composite reliability), convergent validity (factor loadings, AVE values) and discriminant validity (The Fornell-Larcker Criterion) [7]. In order to evaluate the model, WarpPls package program was used and results are presented in Table 2.

Table 2: Validity and Reliability Tests

Item	*Cronbach α*	*Composite Reliability*	*AVE*	*Correlation and Square root of AVE's*					
				Sort	Neatness	Cleaning	Standardize	Sustain	Excellence
Sort	1	1	1	**1**					
Neatness	1	1	1	0,708	**1**				
Cleaning	1	1	1	0,708	0,682	**1**			
Standardize	1	1	1	0,565	0,637	0,549	**1**		
Sustain	1	1	1	0,593	0,597	0,628	0,59	**1**	
Excellence	0,96	0,964	0,64	0.73	0,702	0,722	0,676	0,79	**0,8**

Note: Numbers shown in bold are Square Root of Average Variance Extracted of each item

Values more than 0,7 are generally acceptable for reliability considerations [6]. Cronbach alpha and composite reliability values are above the threshold, indicating sufficient reliability (Table 2).

Validity tests comprise divergent and convergent validities. For testing divergent validity, Fornell & Larcker [4] criterion was used. According to this criterion, square root of AVE value for each construct must be higher than all of its correlations with other constructs. As for convergent validity AVE values and factor loadings were examined. For a construct that is convergent valid, its AVE value and factor loadings need to be above 0,5 [6]. Examination of results demonstrated in Table 2 showed that constructs as a whole are valid and reliable.

4. TESTING CONCEPTUAL MODEL WITH STRUCTURAL EQUATION MODELING

After confirming the validity and reliability of the constructs general fit of the structure was evaluated with WarpPls program. Kalaycı explicate that Variance Inflation Factor (VIF) value of a construct is an issue that requires consideration for multi-collinearity concerns [10]. Hair et al. [6] assert that VIF values under "3" can be interpreted as multi-collinearity-free model. In this study, results show that average full collinearity VIF value is 2.882, showing that multi-collinearity will not be a problem.

In this research, authors are inclined to use PLS technique because of the small sample size and the exploration analysis that involves theory testing. In addition, because WarpPls program can handle single item scales, structural equation is solved using partial least squares (PLS-SEM) technique. PLS regression with jackknifing method which provides better results for smaller sample sizes s chosen.

5S variables showed varying effects on excellence in business construct. According to the results, *sustain* has the highest effect on dependent variable with β=0,399 and 0.01 significance level, while *cleaning* affects insignificantly with β=0,077. *Sort, neatness* and *standardize* also affect *excellence* significantly.

Table 3: Structural Equation Modeling Test

Independent Variables	***Dependent Variables***	***Path Coefficients (β)***	***R^2 Value***
Sort		0,182**	
Neatness		0,155*	
Cleaning	Excellence	0,077	0.767
Standardize		0,169**	
Sustain		0,399***	

*Note: "***" 0.01 significant, "**" 0.05 significant and "*"0.1 significant.*

5. CONCLUSION

In this study, the effects of 5S applications on business excellence were measured. In order to measure this effect, a survey was applied to logistics department employees of randomly chosen food production facilities operating in Istanbul and Kocaeli provinces. Data acquired through survey method was subjected to analysis with WarpPls statistical program and results were explicated.

By doing empirical research, bonds between the variables suggested in this study were quantitatively tested; strength and direction of the effects were presented. According to results derived from tests, 5S applications had positive and significant effects on excellence in business variable, excluding *cleaning*. In addition, *sustain* application showed relatively stronger effect on excellence in business. Sustaining is about general discipline that keeps the workflow constant and in order. Thus, it was expected to obtain significant connection between sustain and excellence. Because the error-free process which is the basic indicator of excellence can be achieved through discipline, it might have been perceived as the most important factor on excellence by the directors. Cleaning variable on the other hand, explains general hygiene of the workplace. The reason of the insignificance of cleaning might be stemming from that it is mainly perceived as an ordinary activity, rather than an obligation or a "must" according to the directors. Hence, respondents might not perceive the relevance between excellence and cleaning process. Nevertheless, it is surprising that cleaning doesn't have any significant effect on excellence in food sector where hygiene is very important, and it should be examined in detail in future studies. Although there is no relevant study in the extant literature, several authors assert the power of the 5S applications in management sciences. Hypotheses claimed and results found show that 5S activities have positive effect on excellence harmonious with the studies of Ho, Kobayashi et al. and Zink in different sectors [8, 14, 27].

Taking the results into consideration, utilizing if not embracing 5S applications in business processes would bring improvements and perfection. Thereby, it would be wise for practitioners in food sector to use these applications and urge their employers to do the same. However, this way of thinking can be extended to other sectors, because, philosophies like Kaizen may be implemented into any business procedure in order to bring an organization one step closer to impeccability.

This paper is unique in terms of being first which provides empirical evidence on 5S applications on excellence in business. Moreover, results of this research will be beneficial especially to organizations operating in food sector and to managers who favors philosophies like Kaizen or lean production. In future studies, 5S applications can be applied to other techniques like Kaizen, in order to better understand its role in the literature. Apart from that, utilizing different dependent variables such as satisfaction or loyalty and applying models to different sectors can improve our understanding.

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