RGSA – Revista de Gestão Social e Ambiental
ISSN: 1981-982X
Data de submissão: 26/09/2022
Data de aceite: 16/11/2022
DOI: https://doi.org/10.24857/rgsa.v16n2-025
Organização: Comitê Científico Interinstitucional
Editora Chefe: Christian Luiz da Silva
Avaliação: Double Blind Review pelo SEER/OJS

# ENVIRONMENTAL COMPLIANCE AND FINANCIAL PERFORMANCE OF SHARIAH-COMPLIANT ENTERPRISES – A DATA-DRIVEN ANALYSIS

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## ABSTRACT

**Purpose:** Environmental, social and governance factors have gained significant traction for investors to evaluate their investment decisions and achieve higher impact investments. Societies have had a growing impact on investors to ensure that besides profitability factors, the impact on the environment, society and internal governance criteria are taken into account when allocating funds. This has led to a growing divestment from highly polluting industries and corporations that are not diverse in their workforce, or have a negative impact on the society such as using forced labor. Islamic finance encompasses the principles of Shariah law that put a strong focus on preserving the environment and support the society. Evaluating whether corporations are Shariah compliant with respect to the environment is challenging, as environmental ESG scores may not adequately represent the entire impact on the environment and the Shariah-environment compliance of corporations.

**Method:** This article presents a new data-driven framework for the assessment of Shariah – environmental compliance for corporations in addition to their financial performance.

**Results and conclusion:** An analysis based on large Islamic compliant US listed enterprises indicate strong clustering performance, and differentiation in terms of Islamic environmental compliance versus non-compliance.

**Originality:** The deep learning framework incorporates an unsupervised-random forest learning approach at categorizing environmental compliance while simultaneously estimating the financial performance of these corporations.

**Keywords:** Islamic Compliance, ESG, Environmental Shariah co.

## CONFORMIDADE AMBIENTAL E DESEMPENHO FINANCEIRO DE EMPRESAS EM CONFORMIDADE COM O SHARIAH - UMA ANÁLISE ORIENTADA POR DADOS

## RESUMO

**Objetivo:** Os fatores ambientais, sociais e de governação ganharam um impulso significativo para que os investi dores avaliassem as suas decisões de investimento e realizassem investimentos de maior impacto. As sociedades têm tido um impacto crescente nos investidores, a fim de assegurar que, para além dos fatores de rendibilidade, o impacto no ambiente, na sociedade e nos critérios de governação interna é tido em conta na afetação dos fundos.I sto conduziu a um desinvestimento crescente de indústrias e empresas altamente poluentes que não são diversific adas em sua força de trabalho, ou têm um impacto negativo na sociedade, como o uso de trabalho forçado. O fina nciamento islâmico engloba os princípios da lei da Sharia que colocam um forte foco na preservação do meio am biente e no apoio à sociedade. Avaliar se as corporações estão em conformidade com a Sharia em relação ao mei

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o ambiente é um desafio, já que as pontuações ambientais ESG podem não representar adequadamente todo o im pacto no meio ambiente e a conformidade ambiental da Sharia das corporações.

**Método:** Este artigo apresenta um novo quadro orientado por dados para a avaliação da Shariah - conformidade ambiental para as empresas, além do seu desempenho financeiro.

**Resultados e conclusão:** uma análise baseada em grandes empresas listadas dos EUA que cumprem o padrão isl âmico indica um forte desempenho de clustering e diferenciação em termos de conformidade ambiental islâmica versus não-conformidade.

**Originalidade:** A estrutura de aprendizagem profunda incorpora uma abordagem de aprendizagem florestal alea tória sem supervisão para categorizar a conformidade ambiental, ao mesmo tempo que estima o desempenho fina nceiro dessas corporações.

**Palavars-chave:** Conformidade Islâmica, ESG, Shariah Ambiental co.

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## 1 INTRODUCTION

ESG (Environmental, Social and Governance) has become of increasing interest for investment decisions, taking into account various non-financial factors that may affect the performance of an organization in the long term. Environmental challenges, such as those arising from pollution and wildlife preservation are incorporated into ESG discussions in addition to social considerations, such as those related to unemployment rates and wage disparity. Governments play an important role in ESG via regulating environmental and labor policies and is viewed as an extension to corporate social responsibility. In many instances, it is better to integrate these ESG management practices into the core business strategy instead of considering it separately. This implies that the corporation may identify business areas where the company may achieve a positive impact and this will help them to meet their ESG goals and incorporate sustainable practices (Yoon, & Serafeim, 2022).

Many corporations engage into the publication of their practices to both stakeholders and shareholders. The view is that the sharing of information with the public enhances transparency and outlines their seriousness of investing into sustainable practices. This enhances both consumer confidence and also leads to growing support of investors that aim at investing into corporations with policies focused on the environment.

These CSR-related disclosures may not accurately reflect the activities of the corporation in terms of a full picture, especially when it comes to environmentally related risks. Environmental issues can include both changes in the biodiversity that arises from deforestation and illegal hunting, as well as the change of weather patterns caused by flooding and drought. This may be due to natural disasters such as hurricanes and typhoons as well as the loss of human life and wildlife. Additionally, the degradation of the atmosphere as caused by the reduction of the ozone layer were considerable issues (Devie, et al., 2019; Lindgreen & Swaen, 2010).

Social issues include child labor, unsafe working conditions for employees, and underpayment of employees, which may include slavery. Additionally, human rights violations against peaceful protestors and whistleblowers as well as poor working conditions are other factors that are taken into account. Governance includes factors such as bribery, corruption within governments and information asymmetry. Corruption relating to environmental concerns are particularly prevalent and of concern. Information asymmetry may represent an

unfair advantage when two parties engage into a transaction, as it may lead to a disadvantage of one entity as compared to the other. Furthermore, there may be price fixing, which would imply that the prices are artificially kept high and a general lack of corporate transparency (Armstrong, 2020).

Climate risks represent a significant risk to the health of humans and not only includes malnutrition, but also starvation and increases the likelihood of infectious diseases. When addressing the risks of climate change, then these may be massive for certain businesses in terms of affecting its present and future performance. Severe weather conditions, such as those caused by floods and droughts may damage its physical assets, or may impact the ability to get its products to its consumers. Recent hurricanes and typhoons may further affect agricultural yields, or may reduce the amount of timber available for harvesting if destroyed by wildfires (Folqué, et al., 2021; Zampier, et al., 2022).

Necessarily, questions arise what ESG compliance represents and these are conventionally actions that are taken by the corporation to ensure that it sufficiently ensures the support of environmental, social and governance measures. When focusing on environmental aspects, then the business shall ensure that it is supporting the environment and takes measures to improve it. Environmental compliance can also represent a business opportunity for these corporations, providing customers with products and services that satisfies their demands. It further enables corporations to invest into sustainable energy sources, and reduce long-term their cost associated with energy. Additionally, recycling may provide cost benefits from the re-utilization of materials and reduction in consumption. A good example of this was Volkswagen that advertised their cars to produce fewer emissions, which in turn enhanced their sales. However, the falsification of the emissions reports in addition to the arising labor issues caused serious backlash for the corporation and financial harm (Williams & Nagy, 2020).

Furthermore, if companies pay their employees a living wage, such as they can afford healthy food, get enough sleep and become more environmentally conscious, then this may lead to significant positive environmental impacts. The importance of ESG investment and arising popularity has primarily been due to the positive development of many ESG compliant stocks and growing awareness of investors to invest into corporations that are responsible and have a positive impact on society and the environment.

On an international level, the United Nations launched the United Nations Principles for Responsible Investment (UNPRI) that is a global network of investors that are committed to factor into ESG into their investment analysis and decision making process. The commitment to ESG acceptable investments was significant, reaching more than 22,000 signatories and 59 trillion USD in assets. When it comes to climate change, ESG investments require companies to put a greater focus on disclosing what effect climate change may have on its operations, and the risk management strategies that are in place in order to deal with these issues. Furthermore, the impact of climate change can be quantified in terms of its negative and positive impact on earnings (Singhania & Saini 2021).

For many corporations, the impact of climate change and ESG relevant criteria is visible. In 1750, the CO2 levels within the atmosphere were around 280 ppm, while they are around 400 ppm nowadays, and this has strengthened extreme weather events that cause billions in damage on physical assets. Hurricane Harvey caused more than 125 billion USD in damaged, and Hurricane Maria led to a damage of around 90 billion USD. While climate change is one of the factors, individual actions of corporations such as the pollution of the environment next to their factories, as well as general supply chain, has to be taken into account for the assessment (Nelson, 2018).

For ESG funds, there are several factors that has made it more attractive in recent years. Generally, these funds exhibit lower risk as compared to conventional financial investments, and have a stronger focus on environmental sustainability, workforce diversity and policies related to governance.

While ESG has focused on a variety of factors, there are questions to what distinguishes Islamic principles related to the environment from these ESG principles.

The natural environment has been at the core of Islamic principles and for human development. Climate change has played a major role in changing the temperature and weather patterns throughout the world and led to significant hardship to societies and animals (Abdelzaher, & Abdelzaher, 2017).

Islamic beliefs, traditions and values represent a comprehensive dealing with the environment, which outlines the importance of environmental protection and the preservation of natural resources. Islamic law is very explicit in terms of that the basic elements of nature, such as land, water, fire, forest and light, belong to every living being, and not solely mankind. The Quran and Sunnah are guides to promote sustainable development and Allah commands that humans shall avoid doing any mischiefs and waste resources that can cause a degradation of the environment. The exploitation rights of natural resources is provided based on a guardianship basis. This implies that the right to use another's property is based on securing that it will not be damaged or destroyed (Emari, et al., 2017).

The Quran has specific references to ecology and contains principles for environmental conservation, that guide the teachings on Islamic sustainability as a part of the trusteeship. The guardian shall ensure that all entrusted properties are passed on the next generation in the purest form possible. This implies that the custodian has to live in harmony with other creatures, and every Muslim has the obligation to respect, nurture and care for the environment (Islam, et al., 2014).

Furthermore, environmental corruption that includes industrial pollution, environmental damage or the reckless exploitation and mismanagement of natural resources are disliked by Allah and Muslims shall refrain from it. This implies that waste by excess is strongly discouraged. This implies that environmental conservation is a religious duty and social obligation, without any form of optionality. Accountability and maintenance of resources are critical (Gada, 2014; Martinez, 2022).

The hadiths are particularly focused on the environment which includes the conservation of resources, reclaiming of land and general environmental hygiene. The prophet actively discouraged overconsumption, luxury and lavishness and encourages moderation in every aspect of life. The most famous hadith states that the earth is green and beautiful, and Allah appointed humans to be a guardian of this beauty. The prophet emphasized that no trees or crops shall be destroyed, not even during war times, which implies that sustainable cultivation of land is actively encouraged. Additionally, minimization of waste and the human treatment of animals is paramount (Ghernaout, 2017).

Given the focus of both Islamic law and ESG on the protection of environment, questions arise on the correlation between Islamic compliant stocks and the environmental performance of stocks, quantified by benchmark ESG scores. Machine learning and artificial intelligence has been a critical area for entire industries in leveraging their data to enhance productivity and investment decisions. Furthermore, automation and AI assisted decision making has been at the core of the investment decision making for many funds and enterprises.

## 2 METHODOLOGY

For the analysis of the environmental compliance amongst Shariah-compliant enterprises, an unsupervised deep learning approach was developed. The core objective of the developed framework is to determine the features and parameters that affect most significantly the separation into various classes as well as investigate the feature impact on the estimation of the environmental compliance with respect to the performance of the stock price, and corporate related parameters.

One of the most widely utilized clustering techniques is the k—means clustering algorithm. The algorithm aims to partition the n observations into k clusters and each observation belongs to the cluster with the nearest mean. The objective of the algorithm is to minimize for each cluster the within-cluster variances. If the variances are inadequate to determine the distances and cluster points according to it, k-median and k-medoids clustering algorithms may be utilized as they better represent the Euclidean distances (Fränti & Sieranoja, 2018).

Another important technique is hierarchical clustering, which builds a hierarchy of clusters. This may be done either agglomerative such that each observation has its own cluster and then the clusters are paired when moving up the hierarchy, or divisive, in which all observations start in one cluster, and then the splits are done recursively. Hierarchical clustering has the benefit that it can handle noisy datasets (Pavlidis, et al, 2006).

The most preferable clustering form was the BIRCH algorithm that is a balanced, iterative reducing and clustering using hierarchies, and follows the hierarchical clustering approach. The BIRCH algorithm is versatile with the two major parameters being the number of clusters and the threshold for the separation. The algorithm has several benefits including that it can handle noise within the datasets in order to produce reliable segmentations of the data. The algorithm is a form of hierarchical clustering and utilizes the benefits that it is robust with respect to uncertainty in the data and very efficiently to be executed as compared to conventional agglomerative hierarchical clustering algorithms. This makes the algorithm successful for challenging clustering approaches such as the determination of Shariah compliance (Zhang, et al., 1997).

Besides the clustering, determining both the impact of various features on the clusters, and their impact on the estimation of the environmental performance is essential to determine the correlation of the features. Decision tree approaches have performed well in providing an explanatory framework for deep learning frameworks for the resulting outputs (Audemard, et al., 2022).

We have utilized a random forest approach. Random forest methods belong to the class of ensemble learning techniques (Tang, et al., 2019). In these techniques, the random forest consists of multiple decision trees where the trees are trained by either bagging or bootstrapping. Bagging is an advantageous ensemble technique for enhancing accuracy. Individual decision trees are combined into different bags. From these bags, we select the bag with the highest accuracy to be further branched out. Then, increasing the number of trees that are incorporated leads to an increase in the precision of the estimates or classification. A critical benefit of random forest trees is the reduction of the limitations of the decision trees, specifically when it comes to overfitting (Schonlau, & Zou, 2020).

Our framework benefits from the effective way that random forest algorithms handle missing data. In addition, they do not need excessive hyperparameter tuning to achieve reasonable predictions. We illustrate in Figure 1 the various types of nodes are encountered in a random forest algorithm (Schonlau, & Zou, 2020). We start with the root node, followed by the decision nodes and then the leaf nodes. Each decision node may have multiple leaves or decision nodes. A decision node with multiple leaves represents a subtree.




**Figure 1:** Random Forest graphical illustration

Information theory provides insights into the way decision trees and random forests operate. Specifically, the critical objective for a decision tree is to maximize its entropy or information gain, which is a measure of uncertainty (Ghatasheh, 2014). Given a set of independent variables, entropy increases when the uncertainty is reduced. Higher entropy means that a higher degree of uncertainty has been removed during the training of the decision trees. The main advantage of the random forest method is that the segregation of the nodes is performed randomly through bagging. This process allows the use of different samplings for the training phase.

The integrated unsupervised-random forest framework approach enables to both analyze the differentiation between the various corporations in terms of their environmental compliance, and the major factors exhibiting strong correlation with the environmental factors.

## 3 RESULTS

For the analysis, a comprehensive list of stocks from Shariah compliant Exchange Traded Funds was incorporated. For an exchange traded fund to be Shariah compliant, all the investments need to be into Shariah compliant stocks. This implies that all the enterprises need to adhere to Shariah principles, which forbids these companies to engage into gambling, speculation, alcohol and pork-related activities. Therefore, non-compliant companies are enterprises that have ownership into a forbidden business, or have financial ratios that are greater than 33.33 %. The prohibited business activities can be summarized more broadly into adult entertainment, alcohol, gambling and pork. The selected ETF's are displayed in Table 1. These ETF's represent a large variety of different enterprises that are all Shariah compliant and cover both established enterprises as well as large enterprises in the financial, retail and technology sector amongst others. The holdings of the individual ETFs were consolidated and duplicates were removed.

**Table 1:** Selected Shariah-compliant ETF for the selection of the enterprises

| Ticker | EFT Name |
|---|---|
| **METV** | Roundhill Ball Metaverse ETF |
| **IYF** | iShares U.S. Financials ETF |
| **DUHP** | Dimensional US High Profitability ETF |
| **XLC** | Communication Services Select Sector SPDR Fund |
| **IXP** | iShares Global Comm Services ETF |
| **IXG** | iShares Global Financials ETF |
| **EWCO** | Invesco S&P 500 Equal Weight Communication Services ETF |
| **EUFN** | iShares MSCI Europe Financials ETF |
| **ESPO** | VanEck Video Gaming and eSports ETF |
| **ISUS** | iShares MSCI USA Islamic UCITS ETF |
| **UMMA** | Wahed Dow Jones Islamic World ETF |

For all the constituents, corporate and stock related information was retrieved from Yahoo finance via its API. This included general corporate information, such as sector, name, number of employees, and key performance indicators such as profit margin, EBITDA margin, beta ratio, etc. Additionally, balance sheet, income statement and cashflow statement was extracted and recorded. Furthermore, sustainability parameters such as the investment into certain products such as arms, and the reported ESG scores based on social, governance, environment and overall total ESG scores were extracted.

A summary of cross-plots between social, government and environmental scores are displayed in Figure 2. The cross-plot indicates that there is considerable correlation between governance and social score, while the correlation between environment and government, as well as social are very weak. This represents a critical indication for the deployment of the deep learning analysis framework, given that social and governance scores are strong correlated.

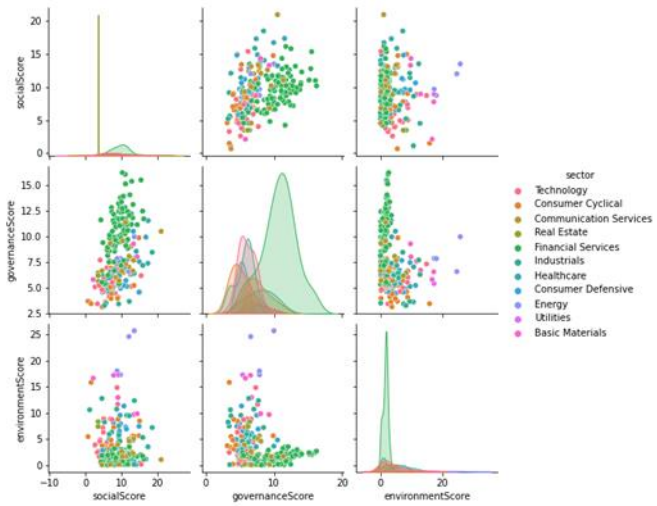



**Figure 2:** Comparison between social, government and environment score, categorized by the sector

The higher the social score, the higher is generally the governance score and vice versa. In contrast, the environment score are rather independent of both social and governance aspects given that the distribution is more in the form of circular cloud distribution as compared to a narrow positively stretched point cloud. This outlines that automatic correlation between environmental compliance and improved social and governance is weak, requiring to have a more robust analysis for determining Islamic environmental compliance of corporations.

While several corporations have solid social and governance scores, which may be reflected in terms of the jurisdiction in which they are located as well as board composition, the corporations may not have a solid environmental record caused by its operations. For example, banks may have solid engagement with the community, firm governance criteria but may provide significant investments into polluting industries, which may be harmful to the environment.

Given that sole ESG compliance scores may not be well indicative of the environmental compliance of corporations, and determining an adequate cluster separation approach. The clustering enables to distinguish between environmentally compliant entities according to Islamic principles and those that may face challenges in terms of their compliance.

This requires another analysis approach to evaluate and separate Islamic environmental compliant and those that may face challenges. The first analysis is based on a comparison between social, governance and environmental score. The clustering algorithm results are displayed in Figure 3 indicating a strong separation related to the environmental score that is particularly visible in comparison with the social and governance score.

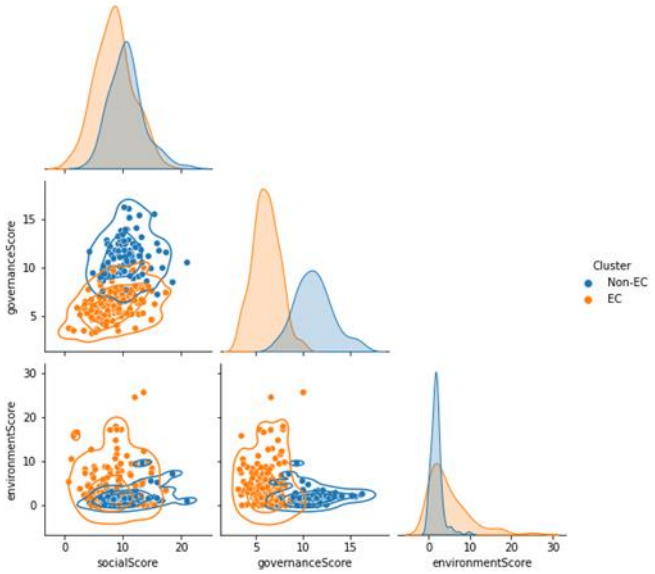



**Figure 3:** Comparison of social, governance and environment score separated into clusters (EC – environmentally compliant, non-EC – not environmentally compliant)

In a separate comparison, the return on equity, gross margins and environment score are presented in Figure 4. The data indicate that higher return on equity and environmental scores are positively related to Islamic environmental compliance. The difference is especially indicative between gross margins and return on equity versus environmental score. There are entities that have high gross margins but with low environmental scores whose Islamic environmental compliance may be subject to challenges.

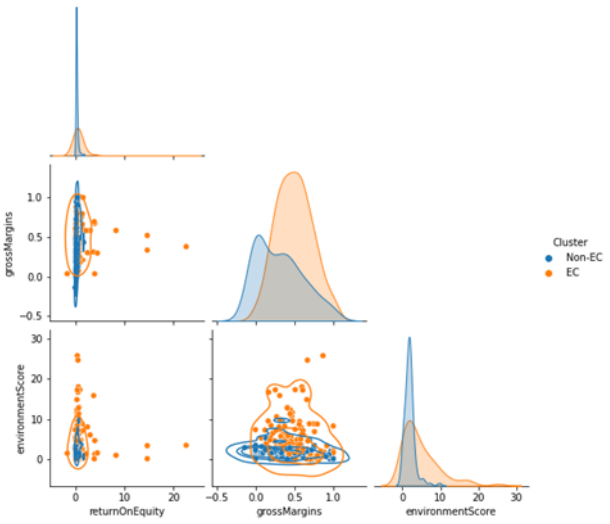



**Figure 4:** Comparison of clusters for the return on equity, gross margins and the environment score.

Furthermore, a comparison of investor recommendation and environmental scores as well as the overall ESG score is displayed in Figure 5. The results indicate that the recommendation for investment may not align with respect to environmental scores. Nevertheless, the clustering is relatively strong achieving a stronger separation related to the environment score.

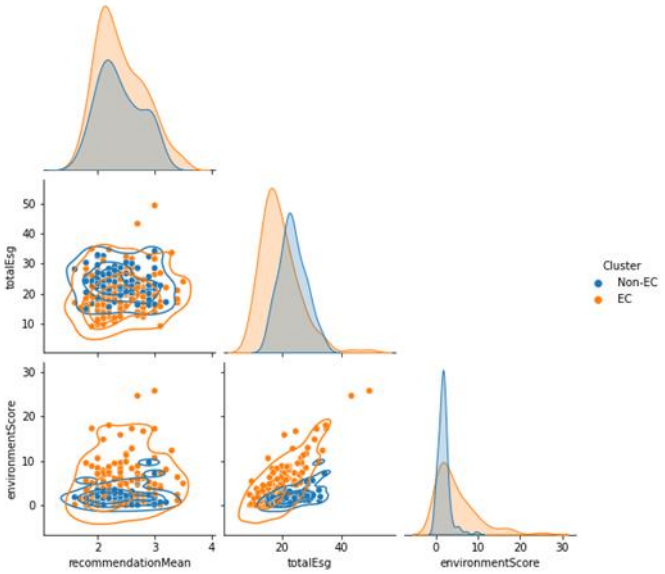



**Figure 5:** Recommendation mean, total ESG and environmental score.

The final comparison relates to the separation of clusters by sector. As can be observed, there is a strong separation for financial services corporations, where several of these institutions may have business transactions that may not be that supportive of achieving environmental sustainability objectives.

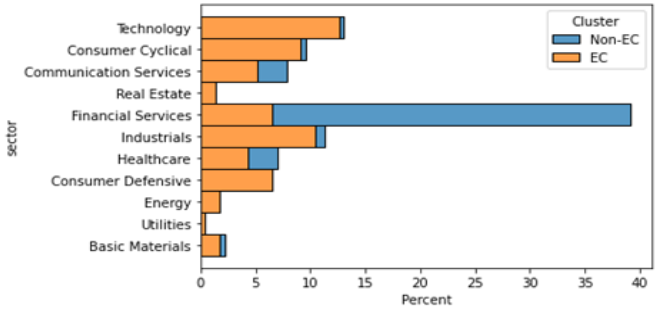



**Figure 6:** Histogram comparison based on clusters.

In order to outline the performance of the framework we display in Table 2 a comparison of the mean key performance indicators for both clusters. The data clearly illustrate the considerably better financial performance of the Islamic environmentally compliant enterprises as compared to those that are not compliant with also a significantly higher environmental score. EBITDA margin is more than twice of that of Non-EC compliant enterprises, while both return on equity and gross margins are considerably better. This illustrates the importance of determining adequately the Shariah environmental compliance as this may lead to stronger financial performance in addition to supporting environmental objectives.

**Table 2:** Comparison of key performance indicators for Shariah environmentally compliant and non-compliant enterprises.

| | **EC** | **NON-EC** |
|---|---|---|
| **EBITDA MARGIN** | 0.278631 | 0.123591 |
| **RETURN ON EQUITY** | 0.995997 | 0.212491 |
| **GROSS MARGINS** | 0.494910 | 0.310714 |
| **ENVIRONMENT SCORE** | 4.774130 | 1.825978 |

## 4 CONCLUSIONS

Environmental, social and governance factors have gained significant traction for investors to evaluate their investment decisions and achieve higher impact investments. Societies have had a growing impact on investors to ensure that besides profitability factors, the impact on the environment, society and internal governance criteria are taken into account when allocating funds. This has led to a growing divestment from highly polluting industries and corporations that are not diverse in their workforce, or have a negative impact on the society such as using forced labor. Islamic finance encompasses the principles of Shariah law that put a strong focus on preserving the environment and support the society. Evaluating whether corporations are Shariah compliant with respect to the environment is challenging, as environmental ESG scores may not adequately represent the entire impact on the environment and the Shariah-environment compliance of corporations. This article presents a new data-driven framework for the assessment of Shariah – environmental compliance for corporations in addition to their financial performance. The deep learning framework incorporates an unsupervised-random forest learning approach at categorizing environmental compliance while simultaneously estimating the financial performance of these corporations. An analysis based on large Islamic compliant US listed enterprises indicate strong clustering performance, and differentiation in terms of Islamic environmental compliance versus non-compliance.

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