REVIEW REPORT OF THE RESEARCH PROJECT: OPPORTUNITY ANALYSIS OF URBAN AGRICULTURE TECHNOLOGY ADDRESSING FOOD SECURITY AND SUSTAINABILITY IN GCC (GULF CORPORATION COUNCIL) COUNTRIES

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INTRODUCTION

The dissertation titled "**Opportunity Analysis of Urban Agriculture Technology Addressing Food Security and Sustainability in GCC (Gulf Corporation Council) countries**" by Muhammad Bilal Khan was submitted to the Department of Business Analytics and Decision Sciences at Leeds University. The main objective is to contribute to the field of business analytics for problem-solving and developing strategies to implement an import substitution model for future benefits.

According to (Ben Hassen and El Bilali, 2019a) Saudi Arabia and many other Gulf countries are the least sufficient in terms of food security. The study further elaborates on the devastating impact of climate change on food security. SWOT analysis has been done using the given data to find out where Gulf States lack. According to (Qureshi, 2020a) the Gulf population is growing and the problem still stands. According to (Kaitibie et al., 2022) 90 percent of Qatar's food consumption is through import. Unforeseen circumstances like COVID-19 increase the cost of food around the globe showing an immense need for an import substitution model (Ben Hassen and El Bilali, 2022).

OBJECTIVES AND SIGNIFICANCE

The objective of this research is to understand future values of production and consumption cost, using SWOT for market planning, implementing an import substitution model, selecting avegetable basket, and adopting vertical farming.

The entire project holds immense importance in terms of economic security, providing social comfort to the general population, adopting new technology, and generating working facilities. It plays a crucial role in economic policy and developing financial strategies. Self-sufficiency through vertical farming is an essential part of the entire project. The research has significant potential to increase supply chain resilience and contribution to the public and private sectors in the field of agricultural innovation.

LITERATURE REVIEW

According to (International Monetary Fund, 2016) report the GCC standard of living increases day to day. The harsh climate conditions make it terrible for GCC to adopt the natural way of agricultural methods. Vertical farming and other advanced hydro technology help them to adopt self-sufficiency by 90 percent claimed by (Al-Chalabi, 2015). According

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to commercial vertical farming increases the potential by 1 billion dollars. The region has the lowest food sufficiency ratio and due to population influx the insecurity is growing a lot according to (FAO, 2019).

According to (FAO, 2008) the population due to expatriates' changes the consumption of food the food influx grows from 1 million tonnes in 2000 to 8 million tonnes in 2016. The population increased 10 times (Al-Khouri and Dhabi, 2012). GCC countries were suffering from two major problems water scarcity and desalinations. Natural farming takes place using groundwater resources that are not sufficient and reliable for long-term economic growth. Irrigation is unsustainable in GCC countries due to its high energy consumption and costly impact (Odhiambo, 2017). The water crisis has been a serious concern for many years traditional farming is unsuitableto fill the gap between supply and demand (Odhiambo, 2017).

The increasing temperature has an immense impact on livestock and agriculture (Ipcc, 2022). The increasing temperature produces serious concerns around the global village. Trade is one of the major factors in terms of food for GCC Countries. Food items are usually perishable and the shortest route serves the GCC interest best, but the cost of cold storage and quality prevention is the biggest challenge.

Vertical farming serves as a solution. To increase economic efficiency and effectiveness multiplemethods have been used such as vertical farming, hydroponics, advance artificial intelligence, LEDs and data analytics to serve better than conventional farming. Indoor vertical farms create a better environment for plant growth (Velazquez-Gonzalez et al., 2022). Recirculating water efficiently reduces water consumption (van Delden et al., 2021). Innovation and artificial intelligence help in improving labor efficiency (Saad et al., 2021). The most powerful tool is a renewable source of energy to provide better agricultural strategies (Mbungu et al., 2020). GCC is working on various projects to improve crop yields. The Kingdom of Saudi Arabia adoptedadvanced house technology to improve its yield and increase production capacity (FAO, 2021). Oman's government project increased vegetable yield twice (Al-Ismaili et al., 2017). Hydroponicsassists in fulfilling the nutritional values of roots. Furthermore, the study found that tomato yield grows efficiently through hydroponics comparatively, growing it in an open field (Nederhoff and Stanghellini, 2010).

GCC understands the challenges the largest vertical farm is in Dubai developed by Emirates with the capacity to produce 27,000 kg daily greens output Many firms produce pesticides one of the renowned examples is Badia Farms (Touliatos et al., 2016). Pure GCC is investing a huge amount in producing high-tech vertical farms Harvest Smart Farms worth $150 million in Abu Dhabi is the biggest example of it (Kurtz, 2021). Multinational farming firms developed large production facilities for vertical farming doing operations in big economies like the USA, China, Japan, Europe, and the Middle East (Despommier, 2009). The facts were very high assuming the cost of farming income and its potential to grow.

In previous studies being conducted in various GCC regions in Oman, a techno-economic model is created for growing different vegetables (Salmi et al., 2020). Qatar and Kuwait spent a huge amount on conducting research for potential returns on vertical farming (Abdullah et al., 2021). A marketing case found $27 million in returns annually for vertical farming by 2025, (Salmi et al., 2020). The challenges are still there for vertical farming including expenses and efficient workers (Baraniuk, 2023). The literature provides in-depth knowledge of innovative economics.

METHODOLOGY AND RESULTS

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THIS CHAPTER EXPLAINS A COMPREHENSIVE PLAN THAT RESEARCH FOLLOWS

Nature of Study

The research is quantitative approach using secondary data further classified as exploratory innature helps to examine causality and novelty between variables. The research will follow onephilosophy: positivism. The positive approach is backed by facts and figures.

ARIMA Model

First, the scope of the research is broad. To have better results a three-vegetable basket is selected including tomato, cabbage, and potato. The r-squared value of the overall model fit value is 82.5%. Tomato showing 85%, cabbage 60.9 %, and potato 56.8%.The Arima auto regression is more reliable and confirms the validity of the entire model. The swot analysis and scenario planning could be easily conducted using the Arima auto regression results

Ethical Consideration

Ethical consideration is considered a foundation pillar of the methodology of any research. For this research transparency and data integrity will be followed to uphold the highest standards for data research and reporting results. The technological tools and methods will be deployed responsibly and adhering to ethical guidelines, to prioritise responsible technological usage, and avoid biases and fairness in algorithmic processes.

Time Horizon

The study was cross sectional in nature, where secondary data is used and information are collectedfor better and reliable results.

RESULTS AND ANALYSIS

The results section for this research uses the ARIMA modeling results to deduce the effects of thevariable on the problem statement Table 1.

Table 1
MODEL FIT

Fit Statistic	Mean	SE	Minimum	Maximum	Percentile						
					5	10	25	50	75	90	95
Stationary R-squared	0.825	0.204	0.371	0.943	0.371	0.371	0.856	0.87	0.938	0.943	0.943
R-squared	0.825	0.204	0.371	0.943	0.371	0.371	0.856	0.87	0.938	0.943	0.943
MAPE	13.009	6.371	6.326	22.316	6.326	6.326	6.344	10.162	18.011	22.316	22.316

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MaxAPE	31.139	16.367	15.638	65.057	15.638	15.638	19.685	26.029	33.642	65.057	65.057
Normalized BIC	28.607	14.363	9.7	51.093	9.7	9.7	17.799	23.619	42.453	51.093	51.093

Model Statistics

The data was taken from the Food and Agriculture Organization from 2012 to 2022. Model fit statistics keeping the predictor as 1 various models were run to find out overall model fit statisticsfor vegetable tomato.

The import value model explained 94.3 % of stationary R squared, the domestic consumption model explained 87% of stationary R squared, the water requirement local harvest model explained 93.8% of stationary R squared, the water requirement import grown local model explained 85.6% of stationary R squared, and the carbon emission model explained 37.1% of stationary R squared Table 2.

Table 2
MODEL FIT

Fit Statistic	**Mean**	**SE**	**Minimum**	**Maximum**	**Percentile**						
					5	**10**	**25**	**50**	**75**	**90**	**95**
Stationary R-squared	0.609	0.313	0.082	0.844	0.082	0.082	0.249	0.792	0.844	0.844	0.844
R-squared	0.609	0.313	0.082	0.844	0.082	0.082	0.249	0.792	0.844	0.844	0.844
MAPE	66.201	100.529	15.026	292.779	15.06	15.026	15.026	37.497	40.078	292.779	292.779
Max APE	384.315	701.784	60.626	1970.83	60.66	60.626	82.693	100.012	196.718	1970.83	1970.83
Normalized BIC	26.956	12.066	13.243	46.689	13.23	13.243	18.273	22.304	38.049	46.689	46.689

Model Statistics

The data was taken from the Food and Agriculture Organization from 2012 to 2022. Model fit statistics keeping the predictor as 1 various models were run to find out overall model fit statisticsfor vegetable cabbage.

The import value model explained 82 % of stationary R squared, the domestic consumption model explained 62% of stationary R squared, the water requirement local harvest model explained 84.4% of stationary R squared, the water requirement import grown local model explained 79.2% of stationary R squared, and the carbon emission model explained 24.9% of stationary R squared Table 3 & Table 4.

Table 3
MODEL FIT

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Fit Statistic	Mean	SE	Minimum	Maximum	Percentile						
					5	**10**	**25**	**50**	**75**	**90**	**95**
StationaryR squared	0.586	0.311	0.131	0.93	0.131	0.131	0.348	0.715	0.915	0.93	0.93
R-squared	0.586	0.311	0.131	0.93	0.131	0.131	0.348	0.715	0.915	0.93	0.93
MAPE	18.154	9.196	8.125	26.845	8.125	8.125	8.439	24.11	26.807	26.845	26.845
MaxAPE	60.801	43.913	18.158	122.789	18.158	18.158	28.01	50.787	122.662	122.789	122.789
Normalized BIC	28.253	13.418	10.953	49.578	10.953	10.953	20.104	23.565	40.938	49.578	49.578

Table 4
MODEL FIT

Fit Statistic	Mean	SE	Minimum	Maximum	Percentile						
					5	**10**	**25**	**50**	**75**	**90**	**95**
Stationary R-squared	0.586	0.311	0.131	0.93	0.131	0.131	0.348	0.715	0.915	0.93	0.93
R-squared	0.586	0.311	0.131	0.93	0.131	0.131	0.348	0.715	0.915	0.93	0.93
MAPE	18.154	9.196	8.125	26.845	8.125	8.125	8.439	24.11	26.807	26.845	26.845
MaxAPE	60.801	43.913	18.158	122.789	18.158	18.158	28.01	50.787	122.662	122.789	122.789
Normalized BIC	28.253	13.418	10.953	49.578	10.953	10.953	20.104	23.565	40.938	49.578	49.578

Model Statistics

The data was taken from the Food and Agriculture Organization from 2012 to 2022. Model fit statistics keeping the predictor as 1 various models were run to find out overall model fit statisticsfor vegetable potato.

The import value model explained 93 % of stationary R squared, the domestic consumption model explained 91.5% of stationary R squared, the water requirement local harvest model explained 34.8% of stationary R squared, the water requirement import grown local model explained 71.5% of stationary R squared, and the carbon emission model explained 13.1% of stationary R squared.

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DISCUSSION AND FUTURE DIRECTION

The entire project focused on providing details on the importance of vertical farming. The projecthighlights the strengths and opportunities for GCC countries and promotes a self-sustainable model. Furthermore, it presents an opportunity for future growth in the field of agriculture. The paper highlights the weakness and threats as well. The cost and fracture planning are huge and adopting agri-friendly technology is a big challenge for GCC countries. The paper used secondarydata and gives a view of a selected basket of vegetables. The future direction could be changing the context and selecting other regions. Additionally, the research could be conducted using otherbaskets of vegetables, crops, and fruits. The research gives immense importance to the field of financial economics. It helps in providing a clear picture to stakeholders and policymakers for future forecasting and analysis. It contributes to the field of economic policy for better governanceand reputation.

CONCLUSION

The project helps in understanding the potential for Gulf countries to produce local crop products using various innovative technologies. The projects help in understanding the scenario planning and conducting SWOT analysis. Additionally, it provides a comparative analysis between conventional farming and vertical farming. It helps in understanding the demand and supply of selected vegetable baskets. It provides the potential in the field of hydroponics. The project helps in understanding the importance of a self-reliance sustainability model for all regions suffering from low rain and changing climate. The model tested domestic consumption, water requirement,and carbon emission as well to help in future forecasting.

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