Chapter 7
GIS Applications With Python for Enhancing Sustainable Operational Performance:
A Focus on Energy Optimization and Resource Flow in Papua New Guinea

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ABSTRACT

The growing complexity and energy needs of the manufacturing sectors in developing countries like Papua New Guinea (PNG) require the incorporation of the modern geospatial and analytical technologies to improve operational efficiencies and sustainability. Python programming, integrated with Geographic Information Systems (GIS), provides an inexpensive and robust mapping, analysis and optimization of energy and resource flows in manufacturing operations. This paper discusses the application of GIS- python models of enhancing sustainable performance of operations within industrial sectors of the PNG and other Pacific Island states as well. It presents a theoretical framework of spatial analytics, energy flow mapping, and resource-optimization using Python automation. Based on case studies of the man-

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ufacturing clusters of Lae and Port Moresby (PNG), and the comparative analysis of Fiji and the Solomon Islands, the study draws measurable areas of efficiency improvements.

1. INTRODUCTION

Manufacturing industry is one of the economic growth sectors that are very significant in developing economies offering jobs, technological development and GDP contribution. Industrialization in urban areas such as Lae and Port Moresby has gained momentum in such nations such as Papua New Guinea (PNG) due to the domestic demand and export oriented industries. This rapid growth, however, goes hand in hand with huge consumption of energy and environmental problems. The manufacturing sectors have to deal with energy restrictions because of insufficient infrastructures, high costs of operation, and overreliance on non-renewable energy sources (World Bank, 2020).

The concept of sustainable operational performance has thus become of critical concern to the manufacturing industry in PNG. Sustainable manufacturing is a concept aimed at maximizing the energy consumption, lessening the waste, enhancing the effectiveness of resources, as well as reducing the impact on the environment and remaining economically competitive (Zhou, Fu, and Yang, 2016). The Geographic Information Systems (GIS) provide a promising method to visually depict and analyze the energy flows and resources allocation in the industrial fields spatially. GIS is coupled to Python programming language it allows the automation of analysis, creation of interactive maps, and combination of different spatial and operational datasets in the decision-making process.

GIS analysis of energy optimization and resource flow can give manufacturing managers and policymakers an understanding of energy-intensive processes, inefficient distribution of resources, and infrastructure planning opportunities. With the GIS-based models, industries can find out the high consumption areas, prioritize the intervention, and track the progress over time. Since real-time monitoring and data-driven decision-making are not as common in developing nations such as PNG, GIS with Python scripting offers an inexpensive and scalable approach that will improve operational performance (Gupta and Singh, 2020).

This paper seeks to examine how GIS applications which have been developed using Python language can be used to improve sustainable operational performance in PNG manufacturing industries. With an emphasis on the energy optimization and resource flow, the research aims to offer conceptual frameworks and the case studies demonstrating the promise of GIS-python solutions to be developed in the developing-country industrial setting. The world manufacturing industries are