



# Analyzing influential indicators in sustainable development of Guangdong Province: The role of circular economy

Ali Hashemizadeh<sup>1,a</sup>, Faezeh Zareian Baghdad Abadi<sup>2,3,b\*</sup>

<sup>1</sup>College of Management, Shenzhen University, Shenzhen, Guangdong, 518060, PR China

<sup>2</sup>China Center for Special Economic Zone Research, Shenzhen University, Shenzhen, Guangdong, 518060 PR China

<sup>3</sup>College of Economics, Shenzhen University, Shenzhen, Guangdong, 518060 PR China

<sup>a</sup>E-mail address; ahz@szu.edu.cn

<sup>b</sup>E-mail address: zareian@emails.szu.edu.cn

\*Corresponding Author

**Abstract.** The rising difficulty of economic planning due to of different impacted aspects and aims needs a thorough examination of important economic development criteria. While few variables in economic investigations lead to unrealistic conclusions, five indicators are used in this study to represent the circular economy, social, environmental, and energy consumption aspects of sustainable development (Total Energy Consumption, Birth Rate, Wastewater Treatment Rate, Number of Repairs Enterprises, and Number of Existing Environment and Public Facilities Management Enterprises). To evaluate the influence of the specified variables on the sustainable development of the study area, a current machine-learning method called XGBoost was designed. According to Guangdong Province, China panel data from 2010 to 2019, the circular economy is the top priority in sustainable development. The circular economy method of mending and reusing materials has a significant influence on sustainable development. Based on these findings, several policy proposals for proper economic growth in Guangdong Province while taking social and environmental concerns into account are made.

**Keywords:** Circular economy, Economic planning, Sustainable development, Guangdong province, Machine learning

## 1 Introduction

Given the severe environmental issues brought on by the rapid expansion in the extraction and use of natural resources, sustainable development has risen to the top of the agenda [1]. Nowadays, world society is concentrating much more on sustainable development as one of the great problems for humans in the twenty-first century, owing to ecological difficulties created by fast economic expansion [2]. The long-term growth

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of countries is the emphasis of sustainable development. Since sustainable development has different aspects, evaluating different items is necessary to reach practical results.

Many scholars have investigated a wide variety of indicators related to sustainable development in this region, but there are still certain gaps that must be filled using current information [3]. The first discrepancy concerns considered indications. While certain indicators are appropriate for some case studies, they did not accurately depict the situation in other places. The circular economy (CE) is one of the most important ideas that scholars and policymakers have lately focused on. The circular economy may enable economic growth while reducing resource and electricity use [4]. In a social aspect, China's government changed its child policy [5]. It has a variety of social and economic consequences that should be examined. Furthermore, although certain regions are important, they have received insufficient attention in the available literature. In this study, we will address these gaps by taking into account suitable indicators such as the circular economy and birth rate to cover all areas of sustainable development, while utilizing up-to-date data to represent current situations. In addition, Guangdong Province in China was selected for investigation in this research in order to suggest relevant policy implications. Guangdong Province has had the fastest economic development of any Chinese province [6].

## 2 Data collection and methodology

### 2.1 Collected data

This study chooses six variables from the energy, social, circular economy, and environmental domains to explore their influence on sustainable development. The information utilized in this study was derived from 2010 to 2019 for ten years including Economic development (Gross domestic product (GDP)), Energy aspect (Total Energy Consumption), Social aspect (Birth Rate), Circular aspect (Wastewater Treatment Rate and Repairs Enterprises), and Environmental aspect (Environment and Public Facilities Management Enterprises) [7]. Table 1 introduces these indicators.

**Table 1.** – The definition of impactful factor on sustainable development

<i>Indicator</i>	<i>Symbol</i>	<i>Definition</i>
<i>Gross domestic product (GDP)</i>	T	It is the most comprehensive and accurate quantitative estimate of a region's overall economic development.
<i>Total Energy Consumption</i>	F1	It states the sum of energy used for electricity, transport and heating in all industries
<i>Birth Rate</i>	F2	The birth rate is the number of live births per 1,000 in a population in a specific time
<i>Wastewater Treatment Rate</i>	F3	It demonstrates the share of the regional people connected to a wastewater treatment plant in percentage.
<i>Repairs Enterprises</i>	F4	It shows the number of Existing Enterprises in Resident Services, and Repairs field in Guangdong Province.

<i>Environment and Public Facilities Management Enterprises</i>	F5	It reflects the number of Existing Environment and Public Facilities Management fields in Guangdong Province.
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### 2.2 Methodology: machine-learning framework

When the data acquired for a framework do not fulfill many of the requirements of normal regression analysis, the XGBoost approach, developed in 2016, stands out as one of the effective alternatives [8]. When compared to traditional methods, this one is better at matching complicated connections between variables. In an iterative process, XGBoost integrates the predictions of several learners into a single model [9]. Because of the tight links between various variables that may impact sustainable development, we employed the prospective nonlinear effects of each of the presented parameters. As a result, an XGBoost-based model was developed. Figure 1 depicts the conceptual architecture of the XGBoost regression algorithm.

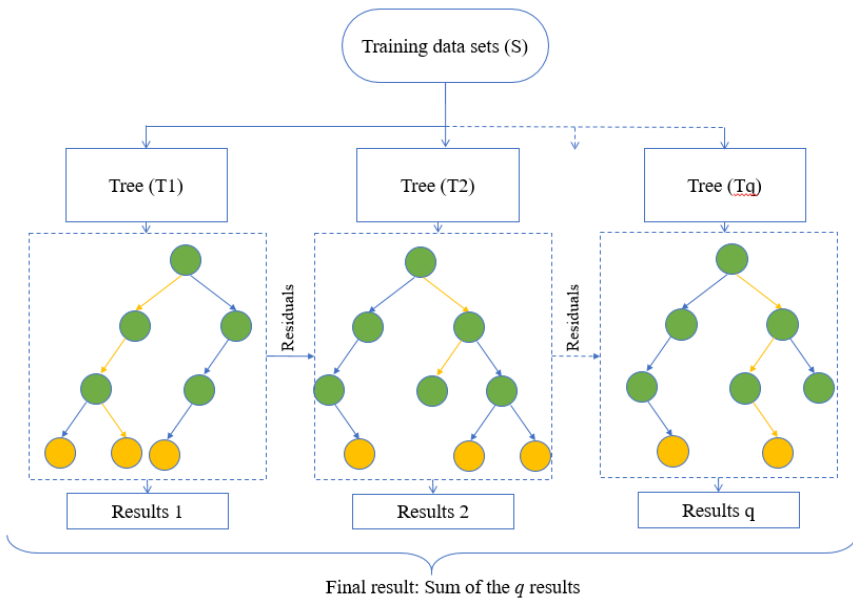
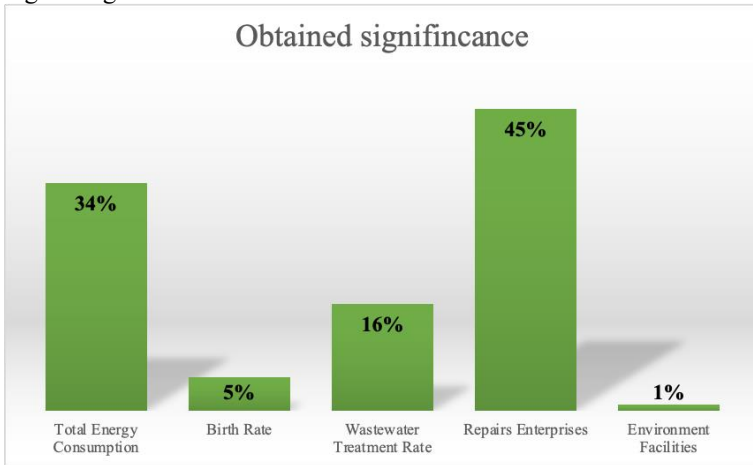


Fig. 1. The XGBoost regression analysis model's schematic structure.

### 3 Results and discussion

The results of the implemented model are reported in this section. Total Energy Consumption, Birth Rate, Permanent Residents, Wastewater Treatment Rate, Repairs Enterprises, and Environment and Public Facilities Management Enterprises were all in-

cluded in this research as impacting elements in sustainable growth, which GDP represented. Figure 2 depicts the influence of the aforementioned factors on the study region's long-term growth.



**Fig. 2.** The obtained significance of considered indicators in the sustainable development of the case study.

According to the findings, the most important indicator is F4 (Number of Existing Repairs Enterprises). Repairing and reusing items is one of the key methods to achieve sustainable development, according to the circular economy principles. At the same time, it increases the efficiency of products consumption while decreasing societal waste. The economy may then be adequately boosted. This result is consistent with, confirming our results [10]. F1 (Total Energy Consumption) is the second most significant indication after F4. Energy is the foundation of all economic activity. Increasing energy usage in an efficient manner may be required for economic progress. Total energy consumption has many effects on societies, and the relevance of this parameter has been underlined in this research, as has been done in the previous literature review [11]. F3 (Wastewater Treatment Rate) is the third indication. It is related to our model's circular economy. The importance of water use and treatment is obvious, particularly given the shortage of water resources. The circular economy idea has the potential to boost sustainable development by increasing the reuse of limited resources. This outcome is consistent with [12].

## 4 Conclusion

Economic activity has lately sparked a variety of concerns regarding unsustainable growth, which may harm people and the environment's functioning. To solve these issues, decision-makers must embrace innovative and long-term solutions. The circular economy is considered as an alternative to traditional economic planning. The circular

economy helps to preserve the closed-loop state of resources, components, and completed items long after they have reached their end-of-life phase in order to acquire value. As a result, it reduces the quantity of waste created throughout the economy, reduces the number of raw materials required for manufacturing, and improves the green environment. The present study proposes finding and analyzing the relevant factors in sustainable development, as well as expanding a model to include the circular economy using the XGBoost regression technique.

In order to take into account, the Economic development, Energy aspect, social aspect, Circular economy aspect, and Environmental aspect of sustainable development, the following indicators have been chosen, in descending order of importance: The gross domestic product (GDP), the total energy consumption, the birth rate, the wastewater treatment rate, the number of enterprises that repair things, and the number of enterprises that manage the environment and public facilities. According to the results of our research, the number of repair businesses is the most relevant element among the parameters that were considered. This is followed by the total energy consumption, the rate at which wastewater is treated, and the birth rate. These findings provided more evidence that the circular economy plays an important part in the process of sustainable development. The circular economy has the potential to increase sustainable development while simultaneously reducing the economy's dependence on resources that do not replenish themselves. In addition, the circular economy may help move us closer to the broader goal of sustainable development by promoting more sustainable habits such as recycling and mending. This might be a significant contribution.

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