Resources, Conservation and Recycling 91 (2014) 40–51

Contents lists available at ScienceDirect

Resources, Conservation and Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

A suggestion for Korean resource productivity management policy with calculating and analyzing its national resource productivity

Il-Seuk Lee [a], Hong-Yoon Kang [a], Kyung-hwan Kim [a,*], In-Ho Kwak [b], Kwang-Ho Park [b], Hyun-Jung Jo [a], Sangjoon An [a]

[a] Korea National Cleaner Production Center, Korea Institute of Industrial Technology (KITECH), Hanshin intervalley24 East B/D 18F, 322 Teheran-ro, Gangnam-gu, Seoul 135-918, Republic of Korea
[b] Research Center of Sustainable Strategy, YESSorg (Your Environment & Sustainability Service Organization) Co. Ltd., Dae-o B/D 307, 148-11, 636 Achasan-ro, Gwangjin-gu,, Seoul 143-802, Repubic of Korea

ARTICLE INFO

Article history:
Received 4 February 2014
Received in revised form 16 July 2014
Accepted 22 July 2014
Available online 14 August 2014

Keywords:
Resource productivity
Domestic resource consumption (DMC)
Gross domestic product (GDP)
Material flow analysis

ABSTRACT

In this study, we suggested a criterion of Korean resource productivity calculation method including its range which is not generalized yet and analyzed its level by reviewing the resource productivity management policies and study trends of the major advanced countries. The material flow indexes that are widely used in major advanced countries, such as the domestic material consumption (DMC), were used to establish the resource productivity calculation method with estimation the domestic resource productivity during 2000–2010. As of 2010, the DMC was 590 million ton, GDP was 1 trillion dollars and DMC-based resource productivity was 1.75 thousand US dollars/ton, which was continuously increased during last ten years with 8.0%, 50.0%, and 38.9%, respectively. This increase tendency was not because of DMC reduction through resource management but because of just large GDP increase. The results of the comparison with other countries indicated that Korea had the lower resource productivity level and also the lower increasing rate than major advanced countries such as the UK and Japan, and required an efficient resource management plan for improvement. Therefore, we finally suggested a Korean resource productivity policy direction to construct its sustainable system for its improvement.

1. Introduction

In Korea, the high-resource-consumption industries such as the steel and automotive industries are serving as the main axes of the national economy, and their raw material imports are continuously increasing. In particular, approximately 97% of their needed resources are imported, but Korea's socio-economic structure is very weak against the fluctuation of international resource prices.

To efficiently respond to abrupt changes in the resource supply environment, major advanced countries, including the EU and OECD member-countries such as Japan, are systematically managing their resources via their governmental resource management system and infrastructure establishment (EC, 2011; Defra, 2013; OECD, 2011; UNEP, 2011). Although Korea has policies for resources, most of them are related to the post-treatment of waste, and there are few resource productivity management policies in the front-of-pipe view, which reduces resource consumption in the production stage and suppresses waste generation.

To establish a national sustainable resource management system, suitable resource management goals and implementation plans must be established by objectively identifying the resource productivity level of industries that consume large amounts of resources, and a systematic evaluation must follow. For this purpose, the quantitative material flow across the entire resource flow processes must be examined via the material flow analysis (MFA), based on which the quantitative index for the national resource productivity can be established for mid- and long-term resource management.

In this study, worldwide policies and study trends on resource productivity management are examined to construct a Korean resource productivity estimation method which is yet established and also the resource productivity of Korea was estimated. In addition, based on the calculation results, efficient systematic use of the national resource productivity index is sought through its comparative analysis with the resource productivity indexes of other countries.

* Corresponding author. Tel.: +82 2 2183 1528/+82 1034699319; fax: +82 2 2183 1529.
E-mail addresses: kkh1984@kncpc.re.kr, k16627@naver.com (K.-h. Kim).

http://dx.doi.org/10.1016/j.resconrec.2014.07.012
0921-3449/

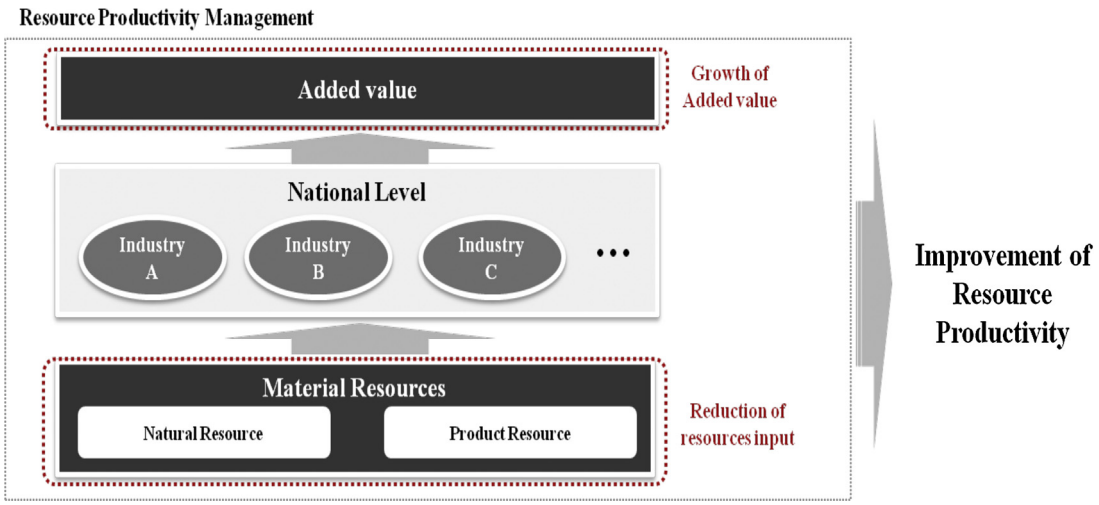

Fig. 1. Concept of resource management.

2. Concept of resource productivity and its index

2.1. Characteristics of resource productivity

Productivity is generally represented by the rate of input production factor for the production of a product or a service, and includes four factors—resources, workers, facilities, and technology and management (Joo, 2011). Therefore, productivity can be defined as an index of the product compared with the production factors, including labor productivity and resource productivity, or as the total factor productivity that reflects all production factors. The total factor productivity can reflect all the production factors, but it makes the calculation and analysis complicated, whereas the productivity based on a single production factor cannot reflect the effects of the other factors. Meanwhile, efficiency improvement is approaching its upper limit in the production structure of modern industries in terms of conventional production factors such as labor and capital (Lee et al., 2013). However, the cost can be reducible in terms of resources via process innovation and design change, which is why "resource productivity" is becoming the core element of total factor productivity innovation. Resources change into the products that have added values through the general production process. The change in resources is directly applied to the added value of the product, and the changes in the other three factors are indirectly applied to the changes in the added values of the resources and products. Therefore, the most efficient productivity evaluation method is to use the resource-productivity index, which means the ratio of the resource to the resulting added value, to represent the productivity management index.

Resource productivity is the term that represents how much added value is created from the resource input to produce products or services in a country or an industrial unit, as shown in Eq. (1). The resource productivity index can be defined as a quantitative index of the resource management level needed to establish the long-term resource management goal for a country or an industry and to continuously evaluate the achievement using the resource productivity concept.

$$\text{resource productivity} = \frac{\text{added value created from the resource input}}{\text{total resource consumption (or input)}} \quad (1)$$

The resource productivity index, which refers to the ratio of the resource consumption to the economic value creation, covers the environmental and economic aspects of resources simultaneously and enables diverse analyses using the resolvents (reuse, resource intensity, added value creation, etc.), with a determined item to be analyzed (Bleischwitz et al., 2009). In addition, the scope and standard of the resource productivity index can be applied to the country and industry (enterprise) in the same way, and the enterprise, industry, and nation can be managed in connection with them.

Resource productivity is highest when decoupling is maximized so that small input resources produce high added value. Therefore, resource productivity management refers to the series of activities to improve resource productivity, which include all activities that minimize resource consumption by reducing the raw materials and by-products in the product and service production process and that maximize the added value of the final-products (Fig. 1).

2.2. Material flow and resource productivity index

In major OECD member countries, the specific management index (the flow and evaluation index) and the mid- and long-term goals for resource management are established based on the results of the material flow analysis (OECD, 2008a). Material flow analysis is an analysis technique that uses the mass balance principle to analyze the physical flow in the process of the inputting of resources into the national boundary, their use in industrial production, their consumption in the market, and their disposal or recycle. Via the material flow analysis, the material flow in the country can be examined in terms of inputs/outputs, and the results can be used to calculate the management index for diagnosing the resource management level in view of productivity and for quantifying the future goal (Moll and Acosta, 2006; Kovanda et al., 2012).

The resource management index that is based on the material flow analysis results can be largely divided into the flow index and the evaluation index. The material index can be defined as 'the factor that quantitatively represents the characteristic of the material flow and material resource use.' It is an important tool for describing the use of a material resource in a specific economic system and for enabling economic efficiency and determining the environmental effect. In addition, the evaluation index, which represents the efficiency of the inputting/consumption of resources using the flow index calculated via the material flow analysis, can be divided into the resource productivity index, decoupling index, factor X, and material resource circulation rate (Table 1) according to the subjects to be considered and the calculation method (KECO, 2010). This resource productivity index widely used in many countries because it is easy to calculate and efficient to evaluate the resource management level. Some researchers merely discuss that decoupling of resource productivity index can be affected to industry structure and economy condition (Hotta, 2010; Jorgenson and