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ARTICLE

A Talk on the Essence of Circular Cities

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ABSTRACT

Research on the essence of policy implementation is the basis for finding solutions. A circular city is founded on the concept of a circular economy, extending from the recycling of single substances to regional resource recycling development. Given limited energy and resource conditions, the emphasis lies in considering right from that source that at the end of a product's service life substances can continue to enter their cycle of re-use and re-utilization. Meanwhile, residual substances can return to the industry and organisms as basic nutrients. The development of circular cities has to be multi-faceted synergetic promotion. Otherwise, it will be deviating from the meaning of the circular essence. In this study, the sustainable development of environment, economy, society and governance aspects were adopted as the starting point for exploring the connotation of the promotion of circular cites. The semi-structured expert interview was adopted as the research method. The pyramid principle was employed to carry out logical inference. The Fishbone Diagram was used to carry out time series analysis in order to ensure relevant requirements do not deviate from the mindset of circular essence during circular city planning. Finally, the 13 circular city planning solutions proposed in the research results and contribution can be specifically provided to agencies engaged in circular city planning and governance. They shall also serve as a reference for circular city solutions.

1. Introduction

The promotion of circular cities starts from defining the essence of circular economies. With essence as the starting point, it can ensure the research and analysis process does not deviate in direction. Circular economies emphasize that right from the product design phase consideration must be given to regarding the materials of different product parts as completely "recyclable" resources (hereinafter referred to as resources) at the end of the product's service life. They can also return to the biological or industrial circular system through decomposition, splitting and reduction procedures, which is the "Cradle to Cradle." C2C mindset. With the concepts and practices of circular economies gradually receiving attention from countries around the world, many countries and cities have begun proposing solutions suitable for the development of their cities.

The concept of circular economies in the narrow sense only takes into consideration transforming a previous

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linear economic model into a circular model. That is, the basic mindset of short-term circulation is gradually converted into a continuously recycled long-term mindset. To achieve sustainable development, considerations from products alone will result in limited promotion effectiveness. The promotion of circular economies is a synergetic and integrative strategy involving multi-layer participation. It has to start from the concept of circular economies in the broad sense. The scope also involves the formulation of circular city-related laws and regulations, geographical environment, industrial R&D momentum, disposal technology, supply chain, the public's consumption quality, market supply and demand and other collaborative operations-related issues. To achieve the long-term goal of sustainable development, we must have more extensively incorporated the circular economy mind into the connotation of sustainable development.

From personal consumption behaviors, group awareness, procurements of enterprise organizations, supply chain integration, city resource recycling, to national policy level, the direction of circular city implementation is an issue involving the overall integrative planning of a city. This study pointed out such an existing problem. The discussion focused on returning circular cities to their "essence." Multi-faceted synergetic package policies and synergetic links must take different aspects into multi-layer consideration in order to bring out synergistic effects. As shown in Figure 1, the complete-cycle circulation of resources must be measured from the source. It is the main core significance that motivated this research.

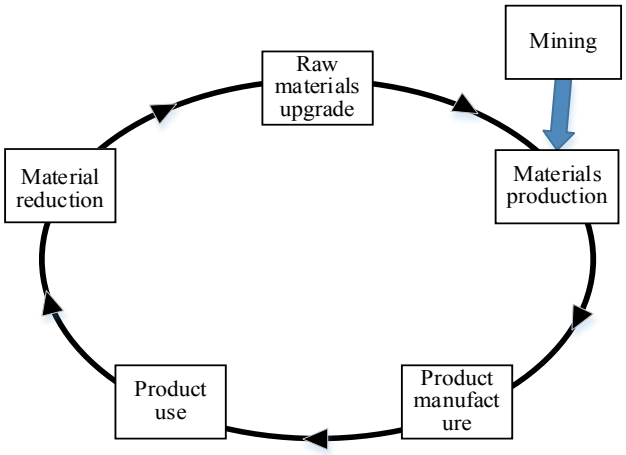

Figure 1. Schematic diagram of a complete cycle of circulation

2. Literature Review

2.1 Circular Economy

The idea of circular economies is the anticipation that various products in use can be more robust, durable, and long-lasting. Moreover, it is the development of renewable energy and the concept of synergy among business, and social actors. Through economic models, positive social and environmental effects can be provided [1]. The circular economy is a sub-issue under eh green economy issue. The United Nations Environment Programme launched the Green Economy Initiative in 2010. The production and consumption patterns in four aspects listed below are taken into account: (1) Improve human welfare; (2) cater to social justice; (3) Avoid the depletion of natural resources; (4) Control environmental risks. The Toward the Circular Economy Report was released at Davos World Economic Forum in Switzerland in 2014. The opportunities and challenges of future global economies terraformed into circular economies were discussed. The report's focuses are as follows: (1) The concept of circulation not only promotes economic growth, but also creates long-term employment opportunities; (2) The circular economy is gradually achieving growth and moving towards globalization; (3) Supply chains will play a vital role in circular economies [2]. A "circular economy" is conceptualized by designing a recoverable and regenerative industrial system, replacing the end of a product's service life with recycling and regeneration and redefining products and services. At the same time, the negative impacts of waste on the environment can be minimized[3]. Waste disposal remains the most important challenge in global waste management. One of the most important objectives of the European Union is to achieve the sustainable development of waste management [4]. Therefore, legal norms and executions are necessary for reducing or stopping the landfill disposal of organic waste [5].

2.2 Circular Cities

There has been a trend towards the development of circular cities in recent years. In 2017, the Ellen MacArthur Foundation specifically pointed out several benefits of a circular economy on a city's policy objectives in the article "Cities in the circular economy: an initial exploration:" (1) it alleviates municipal budgetary pressure; (2) it increases disposable income; (3) it encourages an innovative urban economy; (4) it reduces carbon emissions; (5) it increases urban livability; (6) It produces positive effects especially for increasing employment opportunities [6]. Amsterdam in the Netherlands has incorporated the concept of circular economy into its city governance. Transitioning from the traditional economy towards a circular economy,

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seven principles are complied with, including: Closed loop, Reduced emissions, Value generation, Modular design, Innovative business models, Region-oriented reverse logistics, and Natural systems upgradation. They are used to define the vision of circular cities and action road map [7], which encourage the use of a systematic mindset to provide economic, social and environmental benefits. At the same time, the quality of life is also expected to be improved. In recent years, the circular economy in Taiwan has achieved rapid development, which has been implemented in the livelihood industry. Taiwan's active involvement in the promotion is no less than other countries or regions. Taiwan's Ministry of Economic Affairs, R.O.C. (MOEA) proposed the circular economy promotion plan at the end of 2018 to promote circular technology and material innovation R&D and special zones, construct circular demonstration parks, promote resource integration and industrial symbiosis, and promote green consumption and transactions, four strategies in all. In addition, the two focuses of circular industrialization and industrial circulation serve as the core of the overall governance strategy in Taiwan's circular economy [8]. Taiwan's Taipei City Government officially proposed the Circular Taipei Planning White Paper in July, 2018. With moving towards four environmental, social, economic, and cultural aspects as the sustainable development objective, eight development routes were developed, including: Water Recycling, Energy Optimization, Ecosystem Enhancement, Zero Waste, Shared Mobility, Sustainable Housing, Industrial Innovation and Civic Education. In conjunction with the 17 items of contents, Taipei City's 2018-2022 governance policy blueprint underwent planning to actively head towards circular city promotion.

3. Research Method

3.1 Expert Interviews

The semi-structured expert interview method was adopted. Compared to structured questionnaires, the semi-structured expert interview method can better obtain respondents inner thoughts, thereby accurately understanding their semantics and making up for the inadequacy of the questionnaire contents and scope. In particular, in policy and evaluation system research, the semi-structured interview method is used to play a role in guiding respondents' professional discussion, allowing them to focus on the research objectives. During the expert interview process, the expert interviews were conducted in a relaxing manner as much as possible. The interviewer needed to actively lead the entire interview process to avoid deviating from the research topic and avoid making the interview process too rigid or overcautious.

3.2 Mind Mapping

Mind mapping has been widely applied in various fields. The author in this paper used this method to engage in the hierarchical analysis of smart green building evaluation operations in 2015. The research contents and results were clearly demonstrated by means of mind mapping [9]. Therefore, this study also applied this method to compile the analytical operation hierarchies mad help the team to more explicitly gather collective wisdom and elicit the ideas of each member during research issue discussion.

3.3 Essential Analysis Method

The Essential Analysis Method (EAM) is applied in exploring the hidden causes behind the representation of various problems or variables that possibly exist. Dr. Chang used the EAM method in 2018 to conduct a comprehensive analysis of essential fusion problems faced in cross-strait education systems, teaching models, cultural backgrounds, and mindsets[10]. In 2019, the EAM was applied to conduct an essential research on industrial circular economy [11]. In the article, it is clearly pointed out that if a product fails to include greenhouse gases into the resource recycling life cycle system for review during the process of recycling or use, it will not only result in more resource consumption, but will also increase environmental loads. EAM can be applied in discussing whether or not policy implementation and a system are deviating from the original set goal essence to find the key problems. EAM is a multi-faceted in-depth discussion targeting the main issues. Impact factors possibly related are proposed to effectively review possible causes behind problems. This will help a team more precisely propose solutions targeting existing problems. In particular, when effective solutions for existing problems fail to be proposed, a more balance solution can be employed.

4. The Analysis of the Essence of Circular Cities

4.1 The Basic Mode of Circulation

Based on the essence of life cycle and recycling, from the mining of raw ore (or raw materials) to the end of a product's service life, it can be divided into six stages as the basis for subsequent analysis. The basic model of the life cycle of resource recycling is as shown in Figure 2. The initial essential goal of a circular economy is to reduce resource mining, and the final goal is to ensure all

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substances enter the cycle maximally. The respective stages of a product life cycle, in principle, cannot be detached from six stages. The mining stage can be regarded as the source of raw materials acquisition. Finally, in the final stage at the end of a product's service life, maximum substance recycling and re-use need to be achieved.

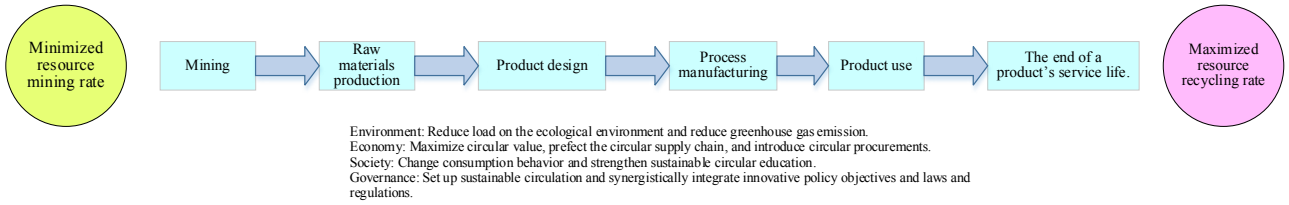

Figure 2. The life cycles of various substance cycles

A life cycle is way of expression in time series. With objectives from four aspects, namely, environment, economy, society, and governance, the analysis contents in different stages can be defined. Subsequently, through expert questionnaires and interviews, the key and secondary factors possibly arising in each stage were analyzed. These impact factors will aid us in discussing factors that actually affect the environment during the process of materials recycling.

4.2 The Conduction of Semi-structured Expert Interviews

Compared to essential researches circular economies, circular cities cover a wider range of discussions. In addition to referring to the current global research data on circular city planning, the research team also invited experts from industry, government, academia, and research related fields to provide professional insights. The interview process and description are as shown in Figure 3. The distribution ratios of expert respondents' fields. Classification was carried out according to the natures of the respondents' units and professional fields. In order to meet the requirements in this research, the education and work qualifications of the invited respondents are limited to those with at least a master's degree or a degree in engineering and related qualifications. Moreover, they must have more than eight years of experience in practical operations at their professional posts or related research. As shown in Figure 4, in response to the research requirements, 32 experts and scholars accepted the invitation to undergo expert interviews. Those working in government agencies and industrial units accounted for up to 58%; the ratio of those serving in academe, scientific research, societies and professional industrial associations accounted for 42%. For the distribution ratios of respondents' professional fields, refer to Figure 5.

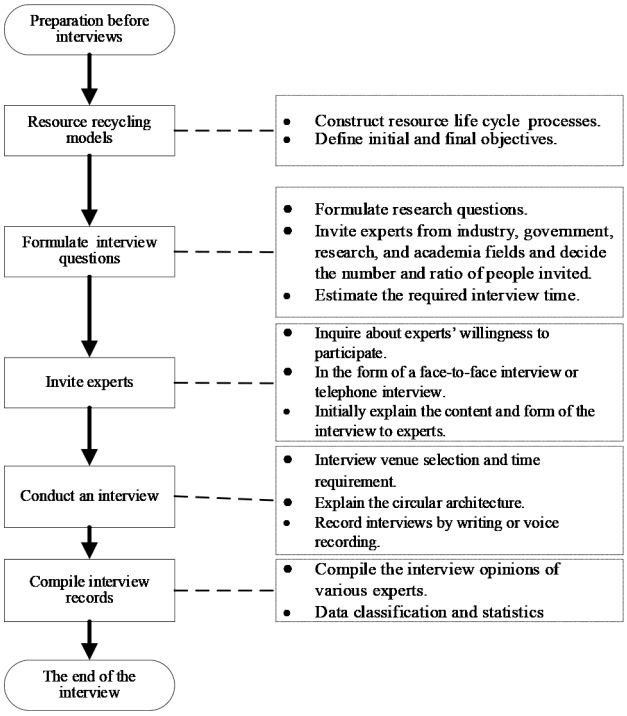

Figure 3. Expert interview flowchart

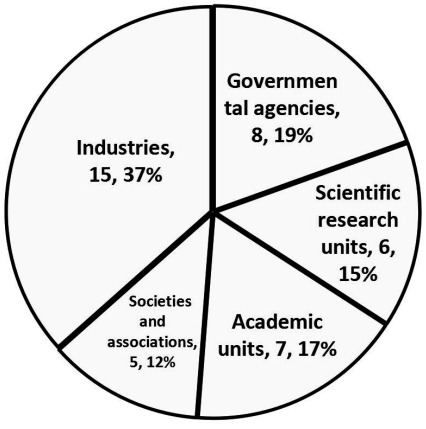

Figure 4. shows the ratios of the natures of the respondents' service units

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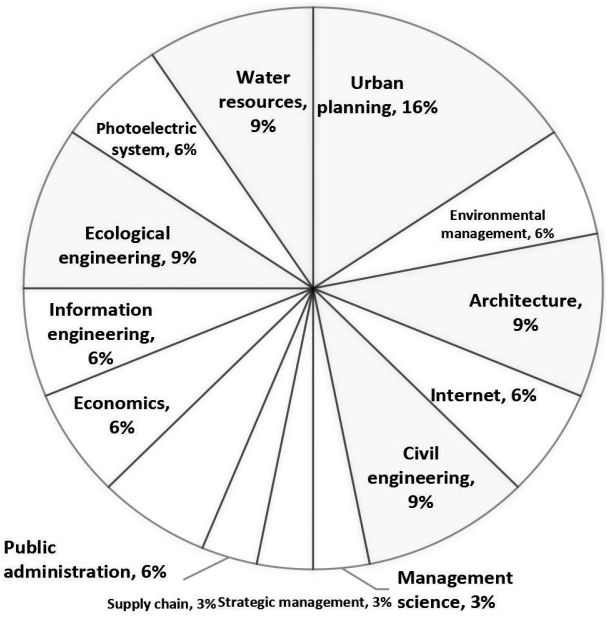

Figure 5. shows the distribution of the respondents' professional fields

4.3 Pyramid Principle

The resource life cycle affects molecular analysis. Under the premise of the same objective, the study made inferences targeting the main key factors. In this paper, the raw materials in the raw materials production stage were used as examples in explaining the pyramid inference process. Pyramid inference is similar to the analytical structure of hierarchical decomposition. For each subs-item under the topic discussed, correlational decomposition items must be carried out according to the set goals. In other words, it takes the support of the various sub-item operations to achieve the primary item goals. Apply the essential analysis method to review and clearly define the input and output under the key image factors are consistent with the original goal and ensure that each support operation meets the set purpose. The inspection content should include elements in the environmental aspect that must be taken into account during the production stage. The checked elements are considered in accordance with the following steps:

(1) The Review or Revision of the Definitions of Nouns:

The definitions of nouns is crucial to the correctness of subsequent operational items. If they are unclear or biased, the correctness of subsequent operational inferences will be affected.

(2) This study is a conclusion-oriented inference process where each task is regarded as an independent sub-system in the inference. As shown in Figure 6 using the raw material in the raw material production stage as the example, the raw materials factors in the raw materials production stage should ensure that the inference direction is based on the final goal (complete recycling, reuse). At the same time, consideration should be given to the executability of the impact factors.

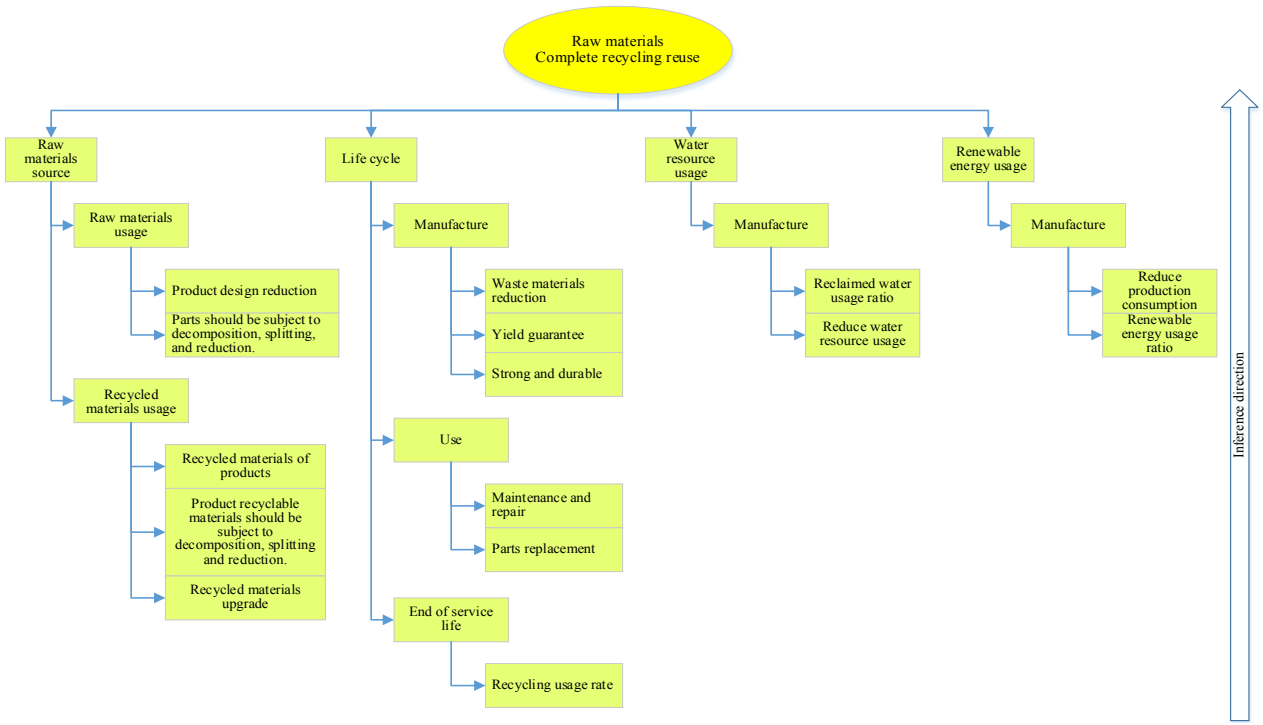

Figure 6. Raw materials production stage-raw materials key factor inference diagram

(3) Time series analysis:

Time series represents a process and time issue analysis. As shown in Table 1 below, the raw materials time series checklist is used as the example. Through group discussion, the review scope must take into account the entire life cycle. Through repeated debates on problems and causes, hierarchical operations must have direct relevance and meet the essential goals of circulation. The review items should be able to reflect their necessity and cover the entire cycle as much as possible.

Table 1. Time series checklist

Life cycle Checking operations		Mining	Product design	Raw materials production	Process manufacturing	Product use	End of service life
Raw materials	Raw materials usage		Reduce raw materials usage through design.	The by-products used for refining raw materials must not cause environmental loads.	In raw materials processing and production, they must not waste additional resources or cause environmental loads.		The parts should be subject to decomposition, splitting and reduction under the natural environment.
	Recycled materials usage		Increase recycle materials use through design?	When reducing or upgrading recycled materials to the expected performance of raw materials, it should not consumption additional resources and cause environmental loads.	Raw materials processing and production should not consume additional resources and cause environmental loads.		Product recycled materials should be subject to decomposition, splitting, and reduction under the natural environment.
	Life cycle		Ensure all product parts can achieve sustainable recycling through design.	Raw materials production and waste reduction	The processing and manufacturing process ensures high yield rates and strong and durable products.	Extend a product's service life through means, technology, and methods.	Increase the recycling and reuse ratio and increase recycling value.
	Water resource usage	The water usage of water resources and the usage of recycled water during raw materials mining?		Reclaimed water usage ratio Reduce water resource usage	Reclaimed water usage ratio Reduce water resource usage		
	Renewable energy usage			Reduce production consumption Increase the renewable energy usage ratio.	Reduce production consumption Increase the renewable energy usage ratio.		

(4) The review of possible reversal points:

When there is not just one cause arising and that problems formed are due to multiple factors, it is possible the true essence of an issue or problem is discussed.

(5) Strategic change or revision model:

When the entire model and essential analysis contradict each other, are not directly correlated, or presents a difference in causal correlation, the system architecture has to be reviewed or the hierarchical structure in the planning criteria must be corrected.

(6) Measurability:

The operations of essential analysis one the one hand serve as a reference during circular city planning; on the other hand, they must be quantifiable to serve as a basis for future planning and performance measurement.

Through the essential analysis method, the purpose of this study is to more clearly present the contents and relevant operations of the respective key impact factors. The realization of the objective of sustainable circular development depends on international cooperation and the active involvement of the government, private society, and private industries.

4.4 Impact Factor Analysis

According to the circular goals, the key impact factors in respective stages of the life cycle are defined. For example, during the mining stage, the goal of achieving sustainable circular development is defined. Energy and water resources are the key impact factors. In view of this, 12 main key impact factors were established and then underwent key factor analysis.

First, based on the corresponding product life cycles, the impact factors in respective stages were listed. The "fishbone diagram" clearly shows the key impact factors in different stages. On the far right is the substance recycling disposal method. The disposal method involves turning substances into materials for final recycling and

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reuse through splitting, decomposition, reduction and auxiliary methods. The analysis of impact factors will aid in finding circular city solutions from environmental, economic, social and governance aspects.

Based on the expert questionnaire results, the secondary impact factors of the key impact factors in respective stages of the life cycle were shown. From the secondary impact factors, the common impact factors were discussed, based on which the highly similar and common impact factor "greenhouse gases" was found. This common impact factor is a key problem that needs to be resolved and prevented from occurring during the resource recycling process, as shown in the red text in Figure 7.

Of course, the issues that need to be resolved in different stages also include other problems conjunctively reviewed and solved. For instance, during the raw materials production stage, the issues also include reducing additive use during raw materials production and adopting low energy consumption technology. It is harder for recycled and manufactured renewable resources to revert to their original physical or chemical properties. Therefore, they must undergo downgrading and upgrading procedures to restore their original performance. In this process, if considerations fail to be fully given during design, more resources will be consumed, leading to more greenhouse gas emissions.

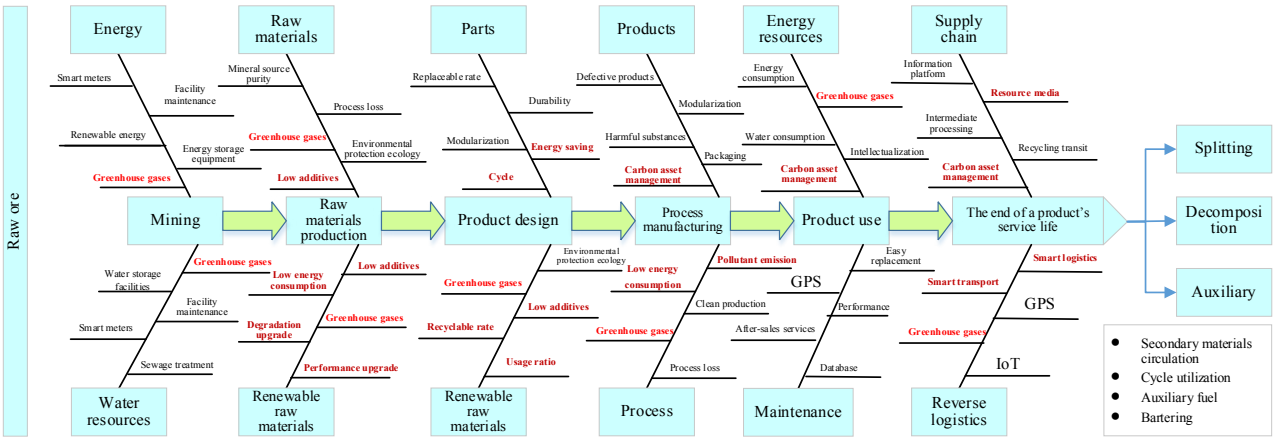

Figure 7. Analysis of resource life cycle impact factors

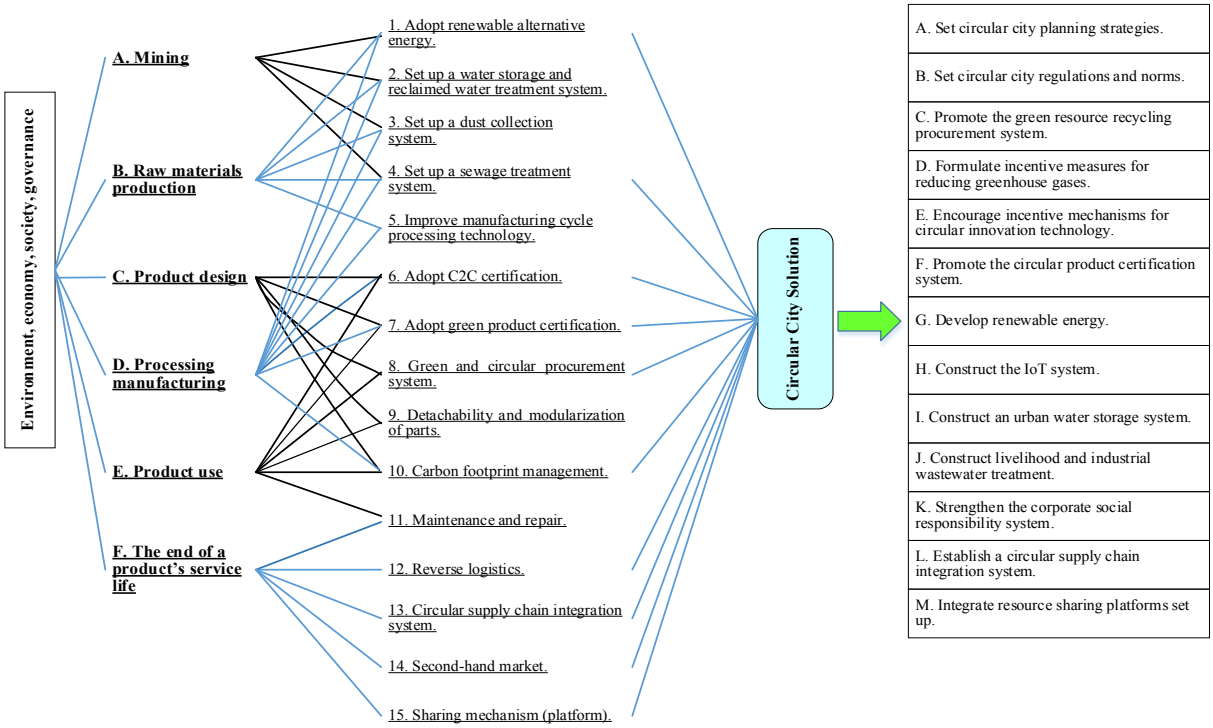

Figure 8. Circular city solutions

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4.5 Recommendations for Circular City Solutions

As shown in Figure 8, after a series of inferences and analysis procedures, the sustainable development aspects of the environment, society, economy, and governance were found to be the very beginning. Through impact factor analysis, in addition to explicitly finding the essential causes, corresponding solutions were obtained. Finally, recommendations for 13 circular city solution plans were put forth.

5. Conclusion

The term "circular economy" not only takes the economic interests aspect into account, but also gives overall consideration to the environmental, social, and governance aspects to achieve synergistic results. In this paper, an important conclusion was found from research inferences. Whether it is new manufacturing or recycling, the essence of a circular economy must achieve the condition of "recycling and re-use of materials of different product parts" right from the source. More importantly, each cycling process must emphasize on the greenhouse gas emission problem and avoid wasting more resources to achieve the original quality requirements and for objects to be recycled. This act not only wastes more resources but also aggravates environmental loads.

With the essential concept of circular economy as the basis and extension into the construction of circular cities, it is conducive to the republic infrastructure of circular cities and the search of more accurate solution, instead of simply getting lost in the economic aspect or sacrificing environmental protection for economic interests. It is especially so for the process of remanufacturing substances where the deviation in environmental destruction does not decrease but increase, which is the second focus mentioned in this article.

The four aspects of sustainable development are combined to construct sustainable circular cities, thereby achieving the essential goals of resource mining reduction and reducing greenhouse gas emissions. From the impact factors of the respective stages of the resource life cycle, 15 corresponding plans were analyzed. Relative to the solutions for constructing circular cities, 13 solutions were proposed in this study. Covering renewable energy and resources, public infrastructure, formulation and cooperation of regulations and norms, circular innovation technology development, and other solutions, the solutions proposed in this study will serve as a substantive reference for constructing circular cities. This is the most important contribution of this research. It shall serve as a helpful reference for circular city planning related units and professionals during development.

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