frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 04 January 2023
DOI 10.3389/fenvs.2022.1079522

A new approach to determine the reverse logistics-related issues of smart buildings focusing on sustainable architecture

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SPECIALTY SECTION
This article was submitted to Environmental Systems Engineering, a section of the journal Frontiers in Environmental Science

RECEIVED 25 October 2022
ACCEPTED 28 November 2022
PUBLISHED 04 January 2023

CITATION
Kadaei S, Nezam Z, González-Lezcano RA, Shokrpour S, Mohammadtaheri A, Doraj P and Akar U (2023), A new approach to determine the reverse logistics-related issues of smart buildings focusing on sustainable architecture.
Front. Environ. Sci. 10:1079522.
doi: 10.3389/fenvs.2022.1079522

Introduction: As the disposal of materials and commodities in the management of construction projects has evolved into a critical issue, certain building materials are likely to be thrown away as rubbish at the end of a structure's useful life. However, tearing down houses and dumping huge amounts of garbage in landfills are not the best feasible solutions to the problem. The depletion and loss of building materials on the project site are exacerbated by the significant amount of waste generated during construction. The tearing down and rebuilding of previously existing buildings are two other methods contributing to rubbish production. Trash management that is as effective as possible has become a need in light of the depletion of natural resources and raw materials, as well as the rise in the pollution brought on by waste from construction projects. One technique that might be taken to address these challenges is the implementation of concepts related to reverse logistics (RL). By considering energy management in construction utilizing sustainability and environmental criteria, this study aims to identify the inverse logistics issues of construction management and smart building.

Methods: An integrated method of multi-criteria decision-making called MARCOS and ordinal priority approach (OPA) for ranking solutions and weighing criteria is presented in this study.

Results: The findings indicate that out of the 23 challenges that must be overcome to implement reverse logistics effectively and achieve sustainability in the construction industry, the one with the most weight and impact on sustainability is "Workforce errors and mistakes during execution."

Abbreviations: HFBWM, hierarchical fuzzy best-worst method; ICT, information and communication technology; OPA, ordinal priority approach; RL, reverse logistics.

Discussion: Out of the ten potential solutions, "determining reverse logistics as a part of a sustainability program" and "strategic collaboration with reverse logistics partners" offer the most viable options for resolving the issue and overcoming the obstacles.

KEYWORDS

reverse logistics, construction management, waste management, construction projects, sustainability

1 Introduction

Nowadays, the issue of reverse logistics (RL) has attracted the attention of many researchers due to the increasing importance of saving raw materials, environmental factors, and government laws (Abazinab et al., 2020). In addition, given the rate of return of 11%–22% of products in the supply chain, manufacturers and distributors always face a major challenge in this area (Ali et al., 2018; Bouzon et al., 2018). Therefore, following to the R.L. process management and controlling the transfer of reutnable goods and products for time and expense reduction, construction management can significantly contribute in facilitating this challenge and stabilizing the competitive position of suppliers in the market (Carter et al., 1998; Brauchle et al., 2015). RL involves all supply chain activities occurring in reverse (Chen et al., 2019).

In RL, the most important principle is that many materials that are so-called unusable for the consumer are valuable and can be re-introduced into construction management with a little modification (Chinda, 2014; Chileshe et al., 2015; Chileshe et al., 2016; Chinda, 2017; Chileshe et al., 20182018). RL has been shown in various forms in the world's military organizations since its inception. In the past, military organizations, for many reasons, did not focus on RL due to their belief that RL is ambitious with a high technology category (Chileshe et al., 2016; Chileshe et al., 20182018). They also believed that RL always hinders the progress of military units. In many of these organizations, RL has not been considered a principle in performance reviews and analysis of their issues (Chinda, 2014; Chinda, 2017). Conducting RL activities by an army unit did not result in any financial profit, possibly due to the limited and less risky power of the military forces (Fleischmann et al., 1997; Correia et al., 2021). Reasons for using RL include the following: 1) Environmental laws and regulations that force companies to collect obsolete goods and products and take extra care in their future production behavior. 2) Instead of paying a high expense for eliminating the waste of second-hand products and raising customer consciousness of the environment, the economic benefits of using the incoming goods in the production line will be provided. 3) Consumers and customers of the logistics system welcome the establishment of R.L. for such reasons as feeling safe due to healthy in demand goods, the guaranteed distributed goods and items, and the borne costs of unhealthy goods from collection to redistribution. 4) The feelings of stability and survival of most system customers using RL are especially evident in large groups of returned goods whose validity and value are reduced over time (Govindan et al., 2015; Govindan and Soleimani, 2017; Govindan and Bouzon, 2018).

The smart city is a multifaceted phenomenon that includes a wide variety of interconnected areas such as transportation, education, healthcare, public security, infrastructure, logistics, information and communication technologies (ICT), and resource utilization (Gu et al., 2021; Richnák and Gubová, 2021; Tavana et al., 2021). These industries influence the daily life of city dwellers. The examples include investment in smart buildings and infrastructure; intelligent transport and mobility; intelligent urban planning, design, and construction; intelligent provision of utilities and management of related equipment systems; development and maintenance of a smart environment; development of the smart economy, government, and politics; promotion and maintenance of people's intelligence; and provision of smart services (Zarbakhshnia et al., 2018; Ritesh Kumar et al., 2019; Apanaviciene et al., 2020; Hashemi, 2021). The smart city concept established during the last few decades evolved its content in response to changes in technology, social structure, environment, and other elements. Without question, supporting governmental policies is critical to developing smart cities (Huang et al., 2020; Liu, 2020; Madueke et al., 2021; Lv et al., 2022).

This study aims to identify the inverse logistics challenges of construction management and smart building by considering energy management in construction using sustainability and environmental criteria and ranking solutions to the occurrence of these challenges.

Compared to previous studies, the innovation and novelty of the present study are based on three principles: 1) ranking the barriers to implementing RL in the construction industry to achieve sustainability in developing countries; 2) providing solutions and ranking them with application in developing countries, and 3) using a new integrated multi-criteria decision-making method. Accordingly, we present an integrated method of multi-criteria decision-making, MARCOS, and an ordinal priority approach (OPA) for ranking solutions and weighting criteria. Although these two methods have many applications, they have not been combined.

In the first step, obstacles to RL implementation are identified. The solutions to the hurdles are found and finalized in the second step. The finished obstacles are weighted using the OPA in the third step. Using the MARCOS technique, the solutions are evaluated for the implementation of the logistics in the fourth step. The weight of obstacles determined in the third phase is used to assess the solutions in this phase.

1.1 Reverse logistics

RL includes all the work done by the logistics unit after the sale and delivery of goods to the customer to complete the product lifecycle. It is a kind of delivery supplement depending on the end customer. It is only done if the goods need to be referred from the customer to the manufacturer, distributor, or supplier (Hosseini et al., 2014; Gu et al., 2019).

RL is very important in the fields of logistics and construction management, which are closely related (Hosseini et al., 2015; Islam et al., 2020). Today, in the developed countries of the world, industrial, governmental, commercial, and service organizations have focused on RL processes and construction management, which play an important role in creating the real economic value of goods and services while supporting environmental considerations (Islam and Huda, 2018; Islam et al., 2020). This focus is increasing in all markets, including industrial and advanced technology and commercial and consumer products (Kopicki et al., 1993; Kazemi et al., 2019). What exists in the traditional flow of goods (besides industry managers that emphasize control and management of that flow) is the direct or forward flow of materials and products, flowing mainly from suppliers to manufacturers, distributors, retailers, and ultimately customers (Krumwiede and Sheu, 2002; Lambert et al., 2011). However, in many industries, another important flow in supply chains is reversed, in which products are returned from lower to higher levels. RL seeks to examine and manage reverse flows, or in other words, reverse flows in supply chains (Meade et al., 2007; Melo et al., 2020).

Among the most significant and essential elements of any industry are RL and closed-loop supply chains, which include the manufacturing and delivery of support services for any form of new product (Morgan et al., 2018; Nel and Badenhorst, 2020). Product returning policies are characterized by quick reaction times and customer support in today's economic era, where the production process is getting shorter and shorter (Nunes et al., 2009; Plaza-Úbeda et al., 2021).

Moreover, the focus on return control, fracture, and re-storage of final products is greater. Recent government regulations and green laws on the treatment and disposal of electronic waste and some other toxic waste also require supply chain logistics executives and senior staff to take a deeper look at the method of RL (Pokharel and Mutha, 2009; Prajapati et al., 2019).

RL refers to the supply chain management processes that manage the activities related to returns, RL input control, and avoidance of duplication within the company and between different supply chain members (Qiang, 2011; Pushpamali et al., 2019). Proper use of this process enables effective management of the flow of the returned products and identification of the opportunities to reduce unwanted returns and control reusable capital. Efficient return management is an essential component of supply chain management that gives the supply chain the ability to gain a sustainable competitive advantage (Rachih et al., 2019).

1.2 Importance and applications of RL

Although many activities can be considered to form RL, some of the most important return management activities mainly specific to this area include repair and replacement, product renovation, remanufacturing, recycling, resale, and reuse (Ravi and Shankar, 2005; Rogers et al., 2012). However, RL is not limited to reuse or recycling. Besides, redesigning packages to use fewer materials or reduce energy and pollution caused by transporting products can also be considered a part of RL called "green logistics" (Rogers and Tibben Lembke, 2001; Sathish, 2019).

Regarding the importance and position of RL in the cost of products, some studies conducted in the United States can be pointed out. These studies show that about 4% of each company's logistics costs are related to return management. However, this share is higher in companies and industries whose products are of a lower quality and do not use advanced technology (Schultmann and Sunke, 2007; Sea-Lim et al., 2018). It should be emphasized that RL depends on the nature of each industry; however, what is certain is that the costs associated with it account for a significant amount of the costs of each industry. In general, this method is more important in industries where the value of products is very high or the percentage of returns shows a significant figure (Sellitto, 2018; Shuang et al., 2019).

RL has existed in various forms in the world's military organizations since its inception. In the past, military organizations, for many reasons, did not focus on RL. They might think that RL is an ambitious category with a high-tech category (Shuang et al., 2019). In many of these organizations, RL has not been considered a principle in performance reviews and analysis of their issues. Conducting RL activities by an army unit did not result in financial profit, probably due to the limited and less risky power of the military forces (Sobotka and Czaja, 2015). Nevertheless, in recent years, commanders, managers, and officials of military organizations, for some reason, have tended to study RL using the methodology of the management process, and the industry has paid much attention to RL (Suyue, 2009). Many European companies and institutions have found that applying a strategy of re-consumption and repackaging of reversible goods (RL) greatly helps improve profitability and reduce environmental pressures. For the past ten years, information resources and books on RL as a new subject have become very scarce (Wang et al., 2019). However, many pamphlets and books have been recently written in this field that have dealt with this issue.

1.3 Reasons for using RL

Undoubtedly, today, with the development of new theories related to customer satisfaction, production is based on customer wants and needs, as well as competitive issues in the market and profitability for major manufacturers, such as large automotive companies and large companies (Yuan, 2014; Wijewickrama et al., 2020). On the contrary, the chain, which is physically and geographically complex, and the impact and expansion of the influence of ICT and the type of correlations that exist between large suppliers and manufacturers have made this issue a significant one.

Generally and historically, manufacturers of goods and items are not responsible for their products after delivery and use by customers and do not assume any liability for their products (Zarbakhshnia et al., 2019; Zarbakhshnia et al., 2020). Today, however, the amount of goods generated has created considerable environmental harm, and everybody, especially customers and officials, is worried about the condition of their environment and is pursuing an improving trend in the state of their environment (Nikabadi and Razavian, 2020). In some situations, everybody wants various manufacturers of goods and items to accept or at least minimize the waste of consumer items, the cost of waste, and waste disposal from their goods (Suyue, 2009).

1.4 Advantages of successful frameworks for RL

Although several enterprises find the return process a necessary evil that should not be considered, it can reap many advantages for businesses that adopt an efficient RL workflow (Zhou, 2011). The workflow of RL can be seen in Figure 1.

These advantages include the following:

Decreased prices, which will reduce associated costs by arranging returns ahead and getting the return order correct (e.g., administration, shipping, transportation, tech support, and QA).

Quicker service, which is related to the initial supply of goods and the return/reimbursement of products. Quick refunds or replacement of products will help restore a client's confidence in a brand.

Retention of clients, which is as necessary to deal with mistakes as to make sales. Managers must do things right if a consumer has had a poor experience with their product. Fulfillment blunders can be possibilities for education (knowing ways to keep the clients happy and participate in managers' ventures, even after managers have got it wrong).

Decreased losses and unplanned earnings: the lost investment in the failed product will be recovered by fixing and restocking the component, scrapping it for parts, or repurposing it in a secondary market. Managers do not need to leave money on the table with a good RL program (Suyue, 2009; Wang et al., 2019; Wijewickrama et al., 2020).

1.5 RL dimensions

1.5.1 Distribution

The main pillar of RL is proper execution during reverse distribution. The principle of integration of the reverse distribution system with its other dimensions is of considerable importance so that the correct performance of different activities and phases of reverse distribution is directly related to the success or failure of an inverse logistics process (Morgan et al., 2018; Melo et al., 2020).

1.5.2 Inventory control and production planning

In RL, to maintain coordination of production with distribution, and to prevent the operations resulted from lack of inventory, some policies, systems and methods must be adopted to sum up the associated costs and reduce inventories (Pokharel and Mutha, 2009; Prajapati et al., 2019; Plaza-Úbeda et al., 2021).

In RL, for better separation of returned items in terms of usability or non-usability, storage should be provided inside the warehouse for "usable return items" and storage for "unusable return items." Then, according to the type of goods and returned items and based on the grading of different stages of continuous improvement in RL, it should be placed in one of the five stages to return to the supply chain if possible (Qiang, 2011; Pushpamali et al., 2019).

1.5.3 Economic savings

In the discussion of the economics of inverse logistics, the structure of reverse distribution channels, the type of distribution channel members, and their functions in these channels are of great importance. In existing resources, RL is often divided into distribution, production, inventory control, and economic savings, to which must be added the IT field, and from an integrated perspective, assume them to be integrated to successfully deploy a reverse distribution system (Kopicki et al., 1993; Kazemi et al., 2019).

1.5.4 RL throughout the construction industry

RL is a method to effectively prepare, execute, and manage the cost-effective supply of raw materials, process properties, finished goods, and relevant details between the point of consumption and the point of origin to retrieve or dispose of value (Pokharel and Mutha, 2009; Plaza-Úbeda et al., 2021). Materials and products are returned for a variety of reasons: broken products (still in the life cycle but out of order), products used in the later stages of the life cycle, unsold products, returned products, waste, and RL, which has attracted much attention in recent years. Classification of RL activities can be classified into four types: repair, reproduction, dismantling, and recycling (Sobotka and Czaja, 2015; Shuang et al., 2019).

RL begins with the parts that are pushed back in the supply chain, that is, the parts collected for recycling or retrieval of value and proper disposal (Zarbakhshnia et al., 2019; Zarbakhshnia et al., 2020).

Increasing waste has become one of the major concerns in industrialized countries because the storage of industrial waste, in addition to occupying a large volume of space, also causes environmental degradation (Gu et al., 2019). In contrast, the increase in destruction costs and existing government laws hold manufacturing companies responsible for the product life cycle (Hosseini et al., 2014). Customers' environmental expectations of reducing waste through recycling have led to the formation of green companies (Hosseini et al., 2015). The issue of RL also covers the construction industry. Reducing the cost of raw materials due to recycling, reducing the cost of packaging the manufactured materials, and reducing the cost of destruction resulting from the reduction of the amount of waste are among the economic benefits for construction companies (Krumwiede and Sheu, 2002). Achieving these benefits requires the creation of an efficient and accurate RL system. Identifying the factors affecting the implementation of RL approaches to the problems and challenges that lie in it, as well as the many values and benefits that come from its practical applications, has made this field of research very attractive. The issues should be studied extensively in scientific and industrial circles (Plaza-Úbeda et al., 2021). Like other manufacturers in their path, mass builders and architects face the issue of returns. Therefore, it is very important to identify the most important success factors in RL and their interaction with each other in managing these processes (Rachih et al., 2019).

In any country, the construction industry is among the major sectors, as it constitutes a huge part of financial investment and positively impacts the economy's growth. Given the financial value of the sector, through the extraction of raw materials to the earlier part structure, all supply chain activities have detrimental environmental and social implications (Correia et al., 2021). A traditional building supply chain includes manufactured goods manufacturers, suppliers, builders, subcontractors, planners, project managers, clients, and consumers. Throughout the industrial supply chain and end-of-life waste production, the ecosystem is seriously influenced by the extraction of raw materials, processing, transportation, and storage (Govindan et al., 2015). In building projects, RL involves transporting the latest building site materials and supplies from recovered houses. Even though there is a variety of research seeking various components of the RL chain, there seems to be no systematic analysis of surveys on this important subject in the construction industry (Hosseini et al., 2015).

More enterprises need to contend with RL. Those who have previously disregarded it are trying to establish systematic processes of RL (Islam et al., 2020). For instance, company representatives collected and destroyed out-of-season merchandise in the early to mid-1990s. Today, businesses employ a third-party company to acquire and repackage surplus seasonal inventory for sale in secondary markets. It is helpful or even important for companies in the greeting card and many other consumer goods sectors to deal with deliveries more efficiently (Islam and Huda, 2018).

In the construction industry, the benefits of implementing RL can be classified into three different categories: environmental, economic, and social dimensions. RL's economic benefits primarily reflect the cost savings of reusing goods (Gu et al., 2019).

1.5.5 RL challenges in the construction industry

Various factors play a role in the return of materials, including changing the role, dimensions, and size of the case; failing to respond to relevant tests and starting the installation process before preparing test results; and lacking a quality assurance system in purchasing materials (Zarbakhshnia et al., 2019; Zarbakhshnia et al., 2020). Although many cases lead to returned goods, in almost all projects, efforts have been made to reduce the number of people. In this regard, it can be said that in construction companies, quality control in the purchase of materials is usually defined and carried out within a specific framework and instructions approved by the employer (Zhou, 2011; Nikabadi and Razavian, 2020).

Monitoring the type and quality of materials is also performed through laboratories trusted by the employer (Zarbakhshnia et al., 2019; Zarbakhshnia et al., 2020). However, the purchased materials may not be approved by the employer or meet the required standard for the execution process (Suyue, 2009; Wang et al., 2019). The order of materials is the contractor's responsibility. At the same time, the employer's consultant is only involved in the quality of the materials (Wijewickrama et al., 2020), but not so in terms of order volume. The monitoring entity must check the quality of the materials entering the workshop according to the relevant roles and instructions (Yuan, 2014). According to the agents, the necessary tests and examinations are performed in the process of purchasing materials. However, the materials sent to the workshop may differ from the selected sample (Zarbakhshnia et al., 2019). With the coordination of the employer and the consultant and according to the records of the companies producing materials, the desired company is selected. In the project, the quality control department controls the quality of materials (Zarbakhshnia et al., 2020). In the case of sensitive materials, the employer directly performs the necessary tests. Even the contractor performs the tests separately. In case of purchasing materials that are not mentioned in the project's technical specifications and have a specific brand, the contractor is obliged to provide some samples to the monitoring entity. After the employer and monitoring entity's approval, the purchase will proceed (Rachih et al., 2019).

In contrast, the consulting monitoring entity visits the production site of materials, leading to a reduction in recyclable materials. Not much attention is paid to the separation and transportation of returned materials. After collection, they are sent to other projects or the central warehouse without special separation (Ravi and Shankar, 2005; Rogers et al., 2012). If such material cannot be returned to the manufacturer, it is sold as waste.

The amount of building waste and its illegal recycling and decommissioning has expanded due to the fast increase in medium and large towns and the lack of proper waste management. Recycling major materials, such as steel, polycarbonate, and glass, is difficult. They are even disposed of in landfills, which could create issues with the ecosystem (Correia et al., 2021). The introduction of RL would also significantly minimize these effects on the environment (Govindan and Bouzon, 2018). Four key RL forms are available: direct reuse, replication, recycling, and landfill. Primary reuse is described as (without modification) "traded items or elements which could be used two times or more". The recycling of a component or item that is used for the first time to create similar material or component of the same performance as the input component is named recycling (Hosseini et al., 2015). Besides, replication is an industrial method wherein obsolete goods are preserved to revive them *via* a series of industrial processes. However, reproduction does not occur exclusively in the building industry. Various rewards allow businesses in their sector to introduce RL (Islam et al., 2020).

1.5.6 Challenges related to waste management

1.5.6.1 Source of waste production: Lack of use of specialized and experienced people in the construction process

One of the important points in construction projects is the need to employ experienced personnel in the implementation phase (Kazemi et al., 2019). This plays an important role in the rate of errors and waste of resources, consequently leading to lower project costs. According to the case project agents, most projects usually use inexperienced staff for cost reduction. Experienced staff are not recruited due to higher salaries and benefits (Kopicki et al., 1993). However, in the organizational structure of projects, the presence of inexperienced forces is also sensible, as these people need workshop experience to gain a position and be useful in the future (Hosseini et al., 2015). The important point in this regard is the inexperienced people's employment percentage compared to experienced people. For example, when the number of inexperienced people is unreasonable compared to those with experience, the experience of the second category cannot compensate for the inexperience of the first (Plaza-Úbeda et al., 2021).

Another point is the entry of people without experience, expertise, and education related to construction. There is a need for more oversight in this regard by the relevant institutions to prevent the activities of such people. In addition, the selection of specialized builders, as well as experienced and suitable suppliers by the contractor and the non-use of component contractors and inexperienced and non-specialized personnel, can be considered one of the important factors in reducing construction waste (Pokharel and Mutha, 2009; Prajapati et al., 2019).

1.5.6.2 How to manage waste: Lack of a basic mechanism for waste collection

The waste collection includes two dimensions: 1) initial collection in workshops and collection of waste from all workshops for sale and 2) sending waste to recycling centers for disposal. In the workshops, the collection is performed by workforce and small vehicles, often rudimentary and unprincipled. Due to improper collection and repeated relocations, some wastes may be further damaged, losing the possibility of recyclability and becoming waste (Krumwiede and Sheu, 2002; Lambert et al., 2011). Private companies also collect and transport waste and rubbish from workshops. In the case of marketable waste, transportation is done by the buyer. In this case, loading is done manually or with non-standard equipment, which can lead to more damage to recyclable waste (Meade et al., 2007).

However, as the collection and transportation of waste are performed by vehicles of private companies and buyers of waste, the amount of transportation will increase if measures can be taken to reduce the amount of road transportation (Peng et al., 2020; Peng et al., 2021a; Peng et al., 2021b; Younesi Heravi et al., 2022). For example, vehicles transporting the required goods to the site can remove waste and debris and improve transportation processes. Another effective measure that can be taken in this case is the requirement to use a system of mechanized waste collection and transportation and a ban on traditional vehicles in this area. It is also necessary to move and transport materials with the help of an experienced worker and under the supervision of an executive technician (Morgan et al., 2018; Melo et al., 2020).

1.5.6.3 Challenges related to the management of recyclable materials

Factors affecting the return of materials include defects and low quality with differences in the performance of materials. One of the reasons for the return of materials due to low quality is consumables (Nunes et al., 2009; Nel and Badenhorst, 2020). One of the main reasons for such failures is financial incentives and the profit of more production units. However, the lack of

TABLE 1 Challenges of RL implementation to achieve sustainability in the construction industry (Source: Author).

No.	Criteria	References
A1	Defects, poor quality, or differences in material performance	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A2	Improper performance of the contractor or employer in purchasing materials	Abazinab et al. (2020), Carter et al. (1998), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A3	Lack of strict control and monitoring of the purchase process, order error	Abazinab et al. (2020), Carter et al. (1998), Chileshe et al. (2015), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A4	Changes in the plan and exploitation policies and, as a result, changes in consumables	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2017), Gu et al. (2019), Liu et al. (2016), Ziaee et al. (2022)
A5	Weakness in transportation and delivery of materials and, as a result, defective materials	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Govindan et al. (2015), Gu et al. (2019)
A6	Lack of written instructions and program for the management of recycled materials	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A7	High costs of recycling materials management	Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A8	Delay in the execution process until the arrival of alternative materials	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Hosseini et al. (2014)
A9	Impossibility of using some materials and turning them into waste (e.g., concrete)	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A10	Inadequate workshop supervision during the implementation process	Abazinab et al. (2020), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Islam et al. (2020)
A11	Poor initial project studies	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Islam and Huda (2018)
A12	Use of low-quality materials	Abazinab et al. (2020), Ali et al. (2018), Brauchle et al. (2015), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A13	Failure to implement quality control and guarantee system	Ali et al. (2018), Chen et al. (2019), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A14	Workforce errors and mistakes during execution	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Gu et al. (2019), Liu et al. (2020), Zhou et al. (2021)
A15	Lack of coordination and interaction between employer, contractor, and designer	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021)
A16	Destruction of materials as a result of delays and interruptions in the project	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A17	Lack of a principled mechanism for waste collection	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Hosseini et al. (2015)
A18	Lack of accurate monitoring and control over the waste management process	Abazinab et al. (2020), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Hosseini et al. (2014), Moayedi et al. (2020), Ziaee et al. (2022), Kadaei et al. (2021)
A19	No separation of garbage before transporting it to the landfill	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A20	Lack of facilities, budget, and specialized technicians in the field of recycling	Abazinab et al. (2020), Chinda (2014), Correia et al. (2021), Govindan and Bouzon (2018)
A21	Negative attitude toward the use of recycled materials in public culture	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Gu et al. (2019)
A22	Lack of awareness and attention to waste and its impact on the environment and the economy of the project	Abazinab et al. (2020), Chinda (2014), Correia et al. (2021), Gu et al. (2019), Zhou et al. (2020)
A23	Improper and illegal disposal of garbage after leaving the project	Abazinab et al. (2020), Ali et al. (2018), Bouzon et al. (2018), Chinda (2014), Correia et al. (2021), Islam and Huda (2018)

TABLE 2 The components of OPA (Source: Author).

Sets	
I	Set of experts $\forall i \in I$
J	Set of attributes $\forall j \in J$
K	Set of alternatives $\forall k \in K$
Indexes	
i	Index of the experts $(1, \ldots, p)$
j	Index of preference of the attributes $(1, \ldots, n)$
k	Index of the alternatives $(1, \ldots, m)$
Variables	
Z	Objective function
Parameters	
i	The rank of expert i
j	The rank of attribute j
r	The rank of alternative k

sufficient knowledge and expertise also causes us to see the sale and supply of non-standard construction items in the market (Pokharel and Mutha, 2009; Plaza-Úbeda et al., 2021). However, improper transportation or packaging of materials may be damaged and defective during transportation or unloading (Prajapati et al., 2019; Pushpamali et al., 2019). As a result, the items will be returned. In this regard, the construction stages and the final quality of construction materials should be periodically audited. At the same time, the necessary tests should be performed to confirm the final quality of construction materials. Following up and supervising the project manager and the employer as much as possible on the stage of preparation and procurement of goods and improving the quality of inspections of the procured goods can also be important (Qiang, 2011).

1.5.6.4 How to manage recyclable materials: Lack of guidelines and writing program for recycling materials

The return of materials occurs in almost every project. However, measures can be taken to minimize returns or, if such items are present in the projects, to be properly managed. The results indicate no comprehensive system for this work in projects. Furthermore, the agents and stakeholders do not value this issue and do not seek solutions to reduce these items (Qiao et al., 2021b; Qiao et al., 2021c; Qiao et al., 2021d; Liu et al., 2021).

The management of recyclable items in construction should be based on a systematic approach, meaning that they should be identified, collected, sorted, and transported under appropriate criteria and guidelines (Ravi and Shankar, 2005; Rachih et al., 2019). Table 1 presents the challenges of RL implementation to achieve sustainability in the construction industry.

1.6 Proposed research framework

This study presents an integrated method of multi-criteria decision-making MARCOS and OPA for ranking solutions and weighting criteria. The first stage is to identify and address challenges to RL implementation. In the second stage, solutions to the obstacles are discovered and finalized. In the third stage, the OPA technique is used to overcome the hurdles. In the fourth stage, the solutions are evaluated for logistical implementation using the MARCOS approach. In this phase, the weight of barriers calculated in the third phase is utilized to evaluate the solutions. Figure 2 shows the current research algorithm.

2 Materials and methods

2.1 MARCOS method

MARCOS method is one of the new methods of multi-criteria decision-making, which means measuring and ranking options based on a compromise solution, which stands for measurement alternatives and ranking according to compromise solution, introduced by Stević and Pamučar (2020). This method is used to rank research options (Ataei et al., 2020; Stević and Brković, 2020; Stević et al., 2020; Khosravy et al., 2021). In addition, to solve the problem with the OPA, the OPA Solver v1.00 software was used.

2.1.1 MARCOS method steps

Step 1: Forming a decision matrix.

The first step in all multi-criteria decision-making techniques aimed at ranking is to form a decision matrix. In the MARCOS technique, the m options are evaluated using the n criteria. Therefore, each option is scored based on each criterion. These scores can be based on quantitative and real values or qualitative and theoretical ones. Either way, a decision matrix $m*n$ must be formed as follows:

$$\begin{matrix} A.A.I. \\ A1 \\ A2 \\ \ldots \\ Am \\ A.I \end{matrix} \overset{C_1 C_2 \; \ldots C_n}{\begin{bmatrix} X_{aa1} \; X_{aa2} \ldots X_{aan} \\ X_{11} \; X_{12} \ldots X_{1n} \\ X_{21} \; X_{22} \ldots X_{2n} \\ \ldots \; \ldots \; \ldots \; \ldots \\ X_{m1} \; X_{m2} \ldots X_{mn} \\ X_{ai1} \; X_{ai2} \ldots X_{ain} \end{bmatrix}}. \tag{1}$$

Step 2: Determining the ideal and the anti-ideal values.

This section determines the ideal (AI) and anti-ideal (AAI) values based on the following relationships. B and C indicate the criteria that have a profit aspect and the criteria that have a cost aspect, respectively:

$$\boldsymbol{AI = \max_i x_{ij} \;\; if \; j \in B \, \text{and} \, \min_i x_{ij} \; if \; j \in C} \tag{2}$$

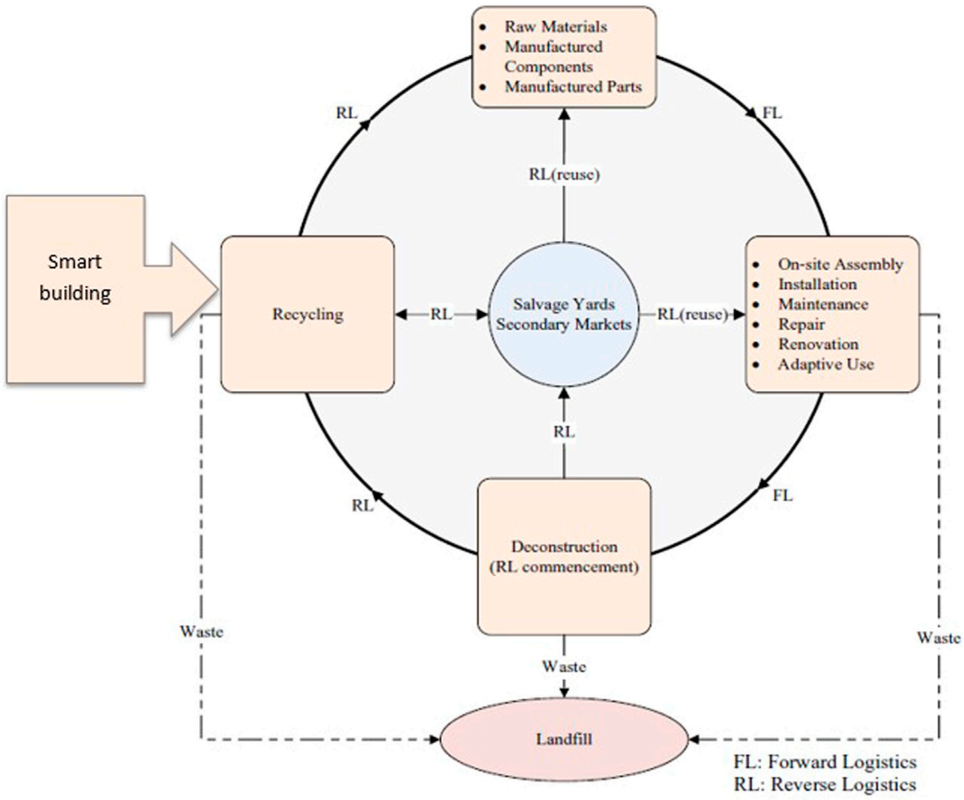

FIGURE 1
RL framework of construction (Fleischmann et al., 1997; Govindan and Bouzon, 2018; Correia et al., 2021).

$$AAI = \min_i x_{ij} \ if\ j \in B and \max_i x_{ij}\ if\ j \in C \tag{3}$$

Step 3: Normalization.

In this section, normalization is performed for cost- and profit-based criteria using the following relationships. The output of this section is a matrix in which all criteria are positive because the normalization method of this method is linear:

$$n_{ij} = \frac{x_{aj}}{x_{ij}} \ if\ j \in C \tag{4}$$

$$n_{ij} = \frac{x_{ij}}{x_{aj}} \ if\ j \in B \tag{5}$$

Step 4: Weighing.

In this section, we multiply the criteria in the normal matrix using the following weight relation to obtain the weighted matrix. BWM weighting is typically used to solve this method. In this study, we used the OPA:

$$V_{ij} = n_{ij} \times W_j \tag{6}$$

Step 5: Discovering the purpose.

In this section, based on the following relationships, the degree of ideal desirability (K^+) and counter-ideal (K^-) of the options are calculated:

$$K_i^+ = \frac{S_i}{S_{ai}} \tag{7}$$

$$K_i^- = \frac{S_i}{S_{aai}} \tag{8}$$

In the above equations, $S_i = (i = 1, 2, 3, \ldots m)$ is the sum of the values of each row in the weighted matrix, obtained as follows:

$$S_i = \sum_{j=1}^{n} V_{ij} \tag{9}$$

Step 6: Determining the final performance and ranking the options.

In this section, the optimal performance of each option is calculated using Eq. 10:

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + 1 - f(K_i^+)/f(K_i^+) + 1 - f(K_i^-)/f(K_i^-)} \tag{10}$$

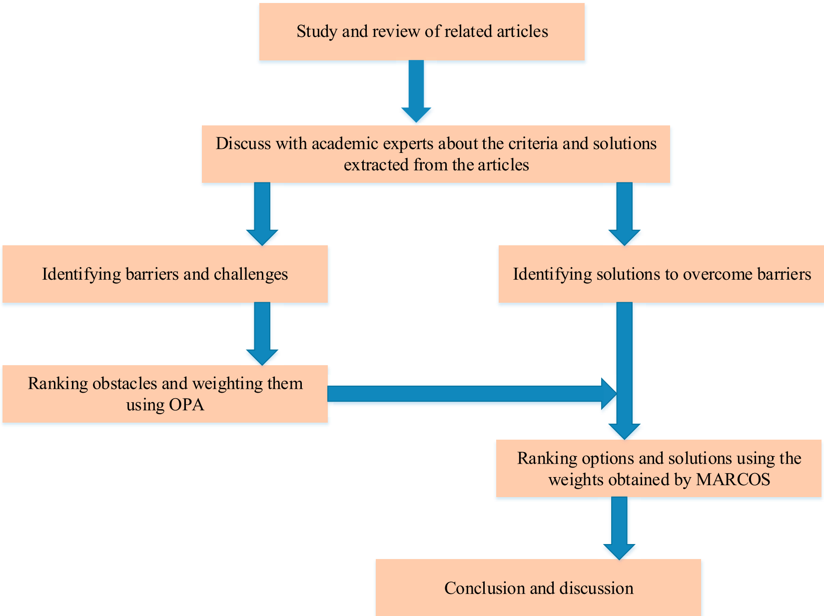

FIGURE 2
Proposed research framework.

TABLE 3 Solutions to avoid obstacles to the implementation of RL to achieve sustainability in construction (Source: Author).

Code	Solution	References
S1	Implementing cross-functional collaboration	Chinda (2017), Islam and Huda (2018), Kazemi et al. (2019), Nunes et al. (2009), Qiang (2011), Ravi and Shankar (2005), Rogers and Tibben Lembke (2001), Bagheri et al. (2021), Yeganeh et al. (2021), Qiao et al. (2021a)
S2	Strategic collaboration with RL partners	
S3	Determining clear policies and processes	
S4	Implementing return avoidance strategies	
S5	Determining RL as part of the sustainability program	
S6	Enforcing environmental legislation, regulations, and directives	
S7	Developing infrastructure and facilities for supporting RL activities	
S8	Implementing green practices for electronic products	
S9	Developing and investing in RL technology	
S10	Establishing e-collaboration among supply chain members	

In the above equation, $f(K^-)$ is the counter-ideal utility performance and $f(K^+)$ is the ideal optimal performance for each option, calculated as

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \tag{11}$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \tag{12}$$

Then, each ranking option is performed based on the numbers obtained from $f(K)$. Each option has a larger $f(K)$ value and a better rank.

TABLE 4 Weight of barriers (Source: Author).

Expert	Rank	Weight
WE1	1	0.391304
WE2	2	0.347826
WE3	4	0.086957
WE4	3	0.173913
Barriers	**Rank**	**Weight**
WA1	16	0.035060
WA2	6	0.052440
WA3	17	0.034630
WA4	18	0.032967
WA5	2	0.062191
WA6	22	0.023513
WA7	19	0.031543
WA8	11	0.046034
WA9	20	0.027801
WA10	21	0.024543
WA11	14	0.040778
WA12	5	0.056118
WA13	23	0.015957
WA14	1	0.078672
WA15	10	0.046135
WA16	7	0.049208
WA17	15	0.040125
WA18	4	0.058689
WA19	13	0.042883
WA20	9	0.047031
WA21	3	0.060231
WA22	8	0.048836
WA23	12	0.044615

2.2 Ordinal priority approach

So far, various methods have been proposed to solve multi-criteria decision-making problems. Meanwhile, the OPA is one of the most recent multi-criteria decision-making methods that can solve individual and group problems even when input data are incomplete. This method requires very simple input data and, after solving the problem, can provide the weight of experts and criteria and the ranking of options. OPA is designed using a linear programming approach, so there is no need for scaling data, averaging methods to aggregate expert opinions, and a pairwise comparison matrix (Ataei et al., 2020; Khosravy et al., 2021).

2.2.1 OPA steps (Ataei et al., 2020; Khosravy et al., 2021)

Step 1: the expert(s) should be identified, and the analyst should determine the rank of each expert. Experts can be prioritized based on work experience, educational level, and other factors.

Step 2: the criteria should be identified and prioritized by each expert.

Step 3: the options should be determined, and then the options in each criterion should be prioritized by each expert.

Step 4: the following linear programming model should be formed and solved:

$$\begin{aligned} & \boldsymbol{Max\,Z} \\ & \boldsymbol{subject\ to}: \\ & Z \le i\left(j\left(r\left(W_{ijk}^{r} - W_{ijk}^{r+1}\right)\right)\right),\ \forall i,j,k\ and\ r \\ & Z \le ijmW_{ijk}^{m},\ \forall i,j\ and\ k \\ & \quad \sum_{i=1}^{p}\sum_{j=1}^{n}\sum_{k=1}^{m} W_{ijk=1} \\ & W_{ijk} \ge 0,\ \forall i,j\ and\ k \end{aligned} \tag{13}$$

where Z is unrestricted sign.

The components of the O.P.A. method are presented in Table 2.

Step 5: after solving the weight model, the options, criteria, and experts are calculated using the following equations, respectively:

$$W_k = \sum_{i=1}^{p}\sum_{j=1}^{n} W_{ijk}\ \forall k \tag{14}$$

$$W_j = \sum_{i=1}^{p}\sum_{k=1}^{m} W_{ijk}\ \forall j \tag{15}$$

$$W_j = \sum_{i=1}^{n}\sum_{k=1}^{m} W_{ijk}\ \forall i \tag{16}$$

2.3 Case study

A construction company is known as a holding company in the construction and sale of high towers in Iran, Tehran. The organization launched RL in the construction industry to meet environmental standards, return warranties, maintain innovation, and configure items to be recreated by competitors. The organization seeks to identify and prioritize RL solutions to reduce the impact of barriers. This review is important to prioritize solutions with the goal that associations may develop appropriate systems to implement these solutions based on the need to overcome

TABLE 5 Decision matrix of the problem (Source: Author).

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
S1	4.5	5	8.5	5	2	2.6	2.5	6.5	6.5	8.5	6.5	4
S2	8.3	2.5	7.6	5.5	9	6.5	5.5	4.5	5	6.5	8.7	3
S3	7.5	4	4	3	1.5	2	5	5	8.5	5	7	5.5
S4	3.5	8.5	8	9.5	5.5	3	3.5	7.5	4	6	5	7
S5	3	2.5	3.9	3	7.5	4	4.5	4	7.5	5.5	2	5
S6	7.8	6.5	3	4.5	1.5	7.5	9	5	7	4.5	9	7
S7	2.4	5.5	6	4.5	3.9	6	5.5	3.5	7	4	5	7.5
S8	2	5	2.5	4.5	5.5	5	5.5	9.5	3	9.5	7.5	5.5
S9	8.5	7	9	7.5	5.5	5	5.5	8.5	10	1.5	7	6
S10	6	5	4.5	4.5	6	6	3.5	5	6.5	6	5	4.5
	A13	**A14**	**A15**	**A16**	**A17**	**A18**	**A19**	**A20**	**A21**	**A22**	**A23**	
S1	5	4.5	2	4	4.5	4.5	7	7.5	6	7.5	5	
S2	6	7	7	4	4.5	4.5	3	4.5	5.5	7.5	6	
S3	5.5	4	5	2	6.9	4.5	5	7	7.5	8	5.5	
S4	7	7.5	4	6	9	7	6	8	5.5	4	7	
S5	5	2.5	6	6.5	9.5	3.5	5.5	3	3	4.5	5	
S6	6	5	9	7	7.9	5	5	3.5	4.5	5	1	
S7	4	5	5.5	8	9.5	6.5	4	8.5	9.5	4.5	4	
S8	2.5	6	4	1	8.5	6.5	6	5.5	3.5	2	2.5	
S9	5.1	5	7	5.5	7.5	6	7	8	6.5	4	5	
S1	5	4.5	2.1	4	4.5	4.5	7	7.5	6	7.5	5	
S10	4.5	5.5	9.5	8	3.5	6	4.2	2	7	3	4	

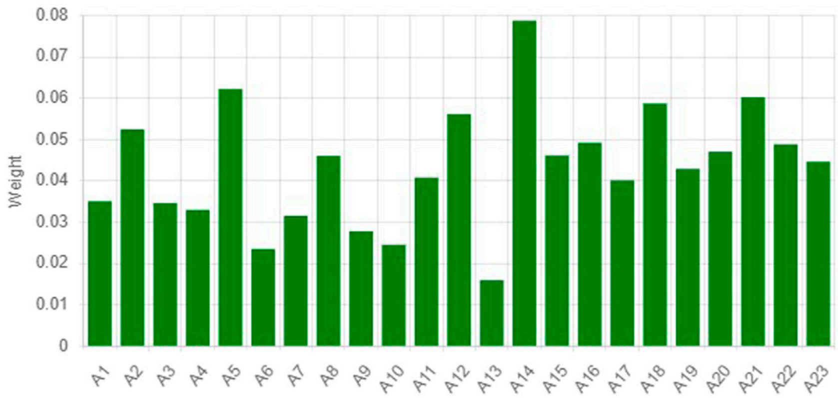

FIGURE 3
The ranking of barriers.

TABLE 6 The amount of AAI and AI for each criterion (Source: Author).

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
AAI	8.5	8.5	9	9.5	9	7.5	9	9.5	10	9.5	9	7.5
AI	2	2.5	2.5	3	1.5	2	2.5	3.5	3	1.5	2	3
	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	
AII	7	7.5	9	8	9.5	7	7	8.5	9.5	8	7	7
AI	2.5	2.5	2	1	4.5	3.5	3	3	3	2	1	2.5

TABLE 7 Rank of solutions (Source: Author).

	S_i	K^-	K^+	$F(K^-)$	$F(K^+)$	$F(K)$	Rank
AAI	0.71375						
S1	0.6190476	0.867	1.215	1.702	2.385	3.342	8
S2	1.0303	1.444	2.022	2.834	3.970	5625	2
S3	0.6666667	0.934	1.309	1.833	2.569	3.599	7
S4	0.6969697	0.976	1.368	1.917	2.686	3.763	6
S5	1.0303031	1.444	2.022	2.834	3.970	5.562	1
S6	0.8444444	1.183	1.658	2.322	3.254	4.559	4
S7	0.7105263	1.995	1.395	1.954	2.738	3.836	5
S8	0.9047619	1.268	1.776	2.488	3.486	4.884	3
S9	0.5934066	0.831	1.165	1.632	2.286	3.203	10
S10	0.6190476	0.867	1.225	1.712	2.395	3.352	9
A.I.	1						

barriers. This research can help partner organizations in developing countries, such as India, Oman, and Iraq, achieve sustainability in the construction industry. The sampling method was purposively using the judgmental method, and the sample size was estimated using Cochran's formula, the value of which was estimated to be 74. Based on the study of research literature and expert opinion polls, the solutions to avoid obstacles to the implementation of RL to achieve sustainability in the construction industry are presented in Table 3.

3 Results

3.1 Ranking and weighting the obstacles

In the first part of the research, we seek to weight the problem criteria (challenges of implementing RL in the construction industry). The OPA was used for this step. The OPA Solver v1.00 software was used to solve the problem of this method. The software output is in the form of tables and figures. In this study, four experts have been selected to rank the challenges and obstacles, all of whom are Ph.D. graduates with relevant work experience in the construction industry. The obtained weight of barriers is presented in Table 4.

It was determined that the rank of the barriers is as described in Table 5. The barriers "Workforce errors and mistakes during execution "have the most weight and impact, and "failure to implement quality control and guarantee system" have the lowest weight (Table 5; Figure 3).

Based on the literature, the present research questionnaire includes sustainability challenges and solutions, which will be confirmed by a questionnaire that measures Cronbach's alpha and its importance. These questionnaires were prepared on a five-point Likert scale (very large, high, medium, low, and very low). In order to measure the reliability of this questionnaire, Cronbach's alpha value was found to be 0.819. The questionnaire can be considered reliable if Cronbach's alpha coefficient is greater than 0.7.

TABLE 8 Final rank of solutions (Source: Author).

Solutions	Rank
Determining RL as part of the sustainability program	1
Strategic collaboration with RL partners	2
Implementing green practices for electronic products	3
Enforcing environmental legislation, regulations, and directives	4
Developing infrastructure and facilities for supporting RL activities	5
Implementing return avoidance strategies	6
Determining clear policies and processes	7
Implementing cross-functional collaboration	8
Establishing e-collaboration among supply chain members	9
Developing and investing in RL technology	10

3.2 Ranking of solutions

First, we obtain the problem decision matrix using consensus and averaging experts' opinions in Table 5.

Now, we calculate the weight by multiplying the obtained matrix by the weight vector in Table 6.

In the final step, we calculated the amount of k^{+}, k^{-}, $F(K^{+})$, $F(K^{-})$, and $F(K)$ and the rank of some alternatives as presented in Table 7:

The final rank of solutions is presented in Table 8.

It is observed that "strategic collaboration with RL partners" and "determining RL as a part of a sustainability program" are the best solutions for this problem. In ranking the most important obstacles, we concluded that the Workforce errors and mistakes during the execution of components weigh more than others, indicating the most important obstacle to achieving stability. In addition, in the second part of the research in the solution ranking phase, we examined ten solutions as research options, and the result was that the two options, "strategic collaboration with RL partners" and "determining RL as a part of sustainability program" have a higher priority compared to other solutions. Organizations grapple with many cultural and structural problems every day. For growth and development in the organization, it is necessary to identify and eliminate basic obstacles and problems. If the problematic culture or structure does not change at the right time, it can destroy the organization, or it will be much harder to make that change in the future. The findings of the present study show Workforce errors and mistakes during execution as an effective element in achieving stability. For this purpose, it is necessary to provide the required training for human resources on sustainability and environmental issues. Accordingly, the present article was conducted through the literature on identifying the challenges and obstacles to the implementation and development of RL in the construction industry. Most of these challenges can be reduced by training staff and managers. Managers today must take the importance of the environment seriously. This will reduce construction and project management costs, even in the short term. One of the most important challenges of conducting this research is the difficulty of completing the questionnaire because the managers of the construction industry, who are experts in the field of intelligence and sustainability, had little time to complete the questionnaire, which takes so much time to complete.

4 Discussion and conclusion

In recent years, companies have paid special attention to the issue of returned products for reasons such as economic incentives, social needs, and environmental laws. As the legal threshold tightens, companies have little choice but to move to RL. RL has become one of the most challenging issues in the field of the construction supply chain. The present study was conducted through the literature on identifying the challenges and obstacles to the implementation and development of RL in the construction industry. Most of these challenges can be reduced by spending time training staff and managers. Managers today must take the importance of the environment seriously. This will reduce construction and project management costs, even in the short term. The most effective approach to this issue has been "strategic collaboration with RL partners" and "determining RL as a part of a sustainability program." Based on our prioritization of the various challenges, we have determined that the most significant barrier to attaining stability is the "Workforce errors and mistakes during the execution" component. In the second part of the study, we ranked ten solutions as potential areas of research and found that "strategic collaboration with RL partners" and "determining RL as a part of sustainability program" are the two that need the most attention. It is not uncommon for businesses to struggle daily with issues relating to their company's culture and organizational structure. A company cannot improve and expand until its fundamental difficulties and issues are resolved. Organizational demise or insurmountable resistance to change is possible if a dysfunctional culture or structure is not addressed at the opportune moment. According to the current research results, human error and blunders in execution play a significant part in ensuring stability.

Some similar research on RL has been published in recent years. For example, Tavana et al. (2021) suggested a fuzzy green supplier selection approach for sustainable RL supply chains. They developed a unique hierarchical fuzzy best-worst method (HFBWM) to calculate the relevance weights of the specified green criterion and sub-criteria. A more advanced assessment approach, the fuzzy extension of Shannon's entropy, is also utilized to generate the criterion weights, giving a reference comparison benchmark. A case study from an asphalt production business is provided to show the applicability and usefulness of the proposed solutions. Gu et al. (2021) created a thorough framework for evaluating RL using a multi-criteria decision-making process to choose the best strategy in case studies of Chinese iron and steel firms to demonstrate the benefits of RL. Richnák and Gubová (2021) investigated the application of green logistics and RL in the context of sustainable development in Slovakian firms. The present study first ranks the barriers to implementing RL in the construction industry to achieve sustainability in developing countries. The second is to provide and rank those solutions with applications in developing countries. The third innovation is the use of a new integrated multi-criteria decision-making method.

However, there were limitations to this research. For example, access to experts in the smart building industry was a bit difficult in developing countries. Most developing countries do not have functional structures for waste storage, collection, and recycling or the proper implementation of waste laws, especially for hazardous waste. As mentioned earlier, RL is a concept that has been considered in recent years to address this issue. Although this concept has attracted more attention in the construction industry in the last decade, in developing countries, this concept has been used only in manufacturing industries. It has rarely been addressed in the construction industry, so industry experts have little knowledge about this concept. The present study provided a platform for more awareness and understanding of the concept of RL. In the construction industry. This study can be considered a guide for developing and implementing RL approaches and activities in construction projects that will play an important role in achieving productivity. The finding shows that the barriers (Workforce errors and mistakes during execution) have the most weight and impact on sustainability. In addition, the solution determining RL as part of the sustainability program has the best alternative for solving the problem and challenges. For future research, it is recommended to use fuzzy methods to classify the barriers to sustainability in the construction industry in developing countries. Developing the proposed integrated model in the hesitant fuzzy space is also recommended. For future study, it is suggested that an approach identifies challenges and risks in smart buildings in terms of RL in sustainability with multi-criteria decision-making under hesitant fuzzy sets. It is suggested that solutions to the challenges be identified and clustered by data mining methods.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and institutional requirements.

Author contributions

SK conceived the presented idea. SK, ZN, RG-L, SS, AM, PD, and UA developed the theory and performed the computations. SK verified the analytical methods. SK, ZN, RG-L, SS, AM, PD, and UA drafted the manuscript with input from all authors. SK, ZN, RG-L, SS, AM, PD, and UA supervised and edited the final version. All authors discussed the results and contributed to the final draft.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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