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Life Cycle Assessment of Internal Wall Panels: A Case Study of Sumerbank Kayseri Textile Factory Restoration Process

Elif ÖZKAYA KIRILMAZ [1], Buket METİN [2*]

ORCID 1: 0000-0002-7957-0510
ORCID 2: 0000-0001-7539-7776

[1] *Abdullah Gul University, Graduate School of Engineering and Science, Department of Architecture, 38080, Kayseri, Türkiye.*
[2] *Abdullah Gul University, Faculty of Architecture, Department of Architecture, 38080, Kayseri, Türkiye*
**** e-mail:** buket.metin@agu.edu.tr*

Abstract

This study presents a case study that aims to select the ideal internal wall panel option causing less environmental impact for the Sumerbank Kayseri Textile Factory restoration process, which is now used as part of Abdullah Gul University's main campus. Since the university has an environmental agenda, examining the environmental impacts of the materials used for the ongoing restoration process has the potential to contribute to these goals. For this purpose, the three most used interior wall panels in the Turkish building material industry, gypsum, reinforced gypsum, and cement-based panels, were selected within the scope of the case study. The life cycle assessment (LCA) method was used to compare these options, and analyses were conducted using SimaPro software. The data required for life cycle impact assessment (LCIA) were obtained based on market analyses and also from the EcoInvent Life Cycle Inventory Database. At the end of the study, damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method were compared and interpreted. According to the overall results obtained for the described case conditions, reinforced gypsum panel causes the most adverse environmental impacts, followed by cement and gypsum panels, respectively.

Keywords: *Ecosystem quality, human health, internal wall panels, life cycle assessment, resource use.*

İç Duvar Panellerinin Yaşam Döngüsü Değerlendirmesi: Sümerbank Kayseri Tekstil Fabrikası Restorasyon Süreci Örneği

Öz

Bu çalışma, günümüzde Abdullah Gül Üniversitesi yerleşkesinin bir parçası olarak kullanılan Sümerbank Kayseri Tekstil Fabrikası restorasyon süreci için çevresel etkiye daha az neden olan ideal iç duvar paneli seçeneğini belirlemeyi amaçlayan bir vaka çalışması sunmaktadır. Üniversitenin tanımlı çevresel hedefleri olduğu için, devam eden restorasyon sürecinde kullanılan malzemelerin çevresel etkilerinin incelenmesi, bu hedeflere katkı sağlama potansiyeline sahiptir. Bu amaçla vaka çalışması kapsamında Türk yapı malzemeleri sektöründe en çok kullanılan üç iç duvar paneli olan alçı, güçlendirilmiş alçı ve çimento esaslı paneller seçilmiştir. Bu seçenekleri karşılaştırmak için yaşam döngüsü değerlendirmesi (YDD) yöntemi kullanılmış ve analizler SimaPro yazılımı kullanılarak yapılmıştır. Yaşam döngüsü etki değerlendirmesi için gereken veriler, piyasa araştırmasının yanı sıra EcoInvent Yaşam Döngüsü Envanter Veri Tabanından elde edilmiştir. Çalışma sonunda, ReCiPe yöntemi tarafından sağlanan hasar değerlendirmesi, ağırlıklandırma ve orta nokta ve bitiş noktası verilerini açıklayan karakterizasyon sonuçları karşılaştırılarak yorumlanmıştır. Örnek çalışma kapsamında elde edilen genel sonuçlara göre, güçlendirilmiş alçı panel en olumsuz çevresel etkilere sebep olurken, onu sırasıyla çimento paneller ve alçı paneller takip etmektedir.

Anahtar kelimeler: *Ekosistem kalitesi, insan sağlığı, iç duvar panelleri, yaşam döngüsü değerlendirmesi, kaynak kullanımı.*

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1. Introduction

Materials used for building element construction have a significant effect on the overall environmental impacts of buildings. They may cause damage to human health, ecosystem quality, and resource use in each phase of the building life cycle that starts with the raw material acquisition and continues with production, construction, and operation phases and ends with defined end-of-life scenarios. Therefore, it is critical to understand the overall life cycle impacts of the building materials to make the ideal selection. Within this context, Life Cycle Assessment (LCA) method provides a comprehensive approach when analyzing and assessing the environmental impacts of building materials. The previous studies use the LCA method when evaluating the environmental impacts of different building materials focusing on various aspects, such as structural system selection, assessing thermal insulation, and waterproofing applications, window system renewal, and internal wall or ceiling assemblies.

Some studies focus on structural system selection in terms of their environmental impacts. For example, Balasbaneh, Bin Marsono & Gohari (2019) evaluated the repairs applied in a flood zone for the non-flood situation and when the flood occurs to identify the feasibility of repairs. For this purpose, they assessed typical brick, concrete block, steel wall panels, wood, and precast concrete framing using LCA and Life Cycle Cost (LCC) methods. On the other hand, Ben-Alon et al. (2019) developed a framework for a comparative LCA with embodied energy and air emission perspectives comparing cob earthen, concrete masonry, and wood frame wall assemblies.

Some studies examine the environmental impacts of thermal insulation materials and applications. As one of the examples, Llantoy, Chàfer & Cabeza (2020) focused on thermal insulation materials suitable for the Mediterranean continental climate by developing a comparative LCA. They aimed to provide a new perspective for selecting insulation materials in terms of their environmental performance when used to reduce energy consumption in buildings. Cetiner & Ceylan (2013) also proposed an approach for assessing environmental performance resulting from rehabilitating existing buildings. The study aimed to reveal the environmental performance of window system renewal and thermal insulation application to the existing buildings for reducing heating energy consumption using the LCA method. There are also a few studies that handle waterproofing applications. One example study is provided by Cetiner & Levent (2022), which examined the environmental impacts of waterproofing applications supplied by the Turkish materials industry to be used in flat roofs using the LCA method.

Internal finishes, such as internal wall and ceiling assemblies, are also studied in LCA studies. For example, Rodrigo Bravo et al. (2022) used LCA to compare two gypsum ceiling tiles: a traditional gypsum and a new eco ceiling tile within the cradle-to-grave system boundary. On the other hand, Cascione et al. (2022) used cradle-to-cradle LCA to compare a circular bio-based wall panel prototype with prefabricated wall panels produced using generic building materials and techniques. The study aimed to support the decision-making process for improving the circular bio-based panel's design during the early design stage. Moreover, Buyle et al. (2019) evaluated the environmental and economic benefits and drawbacks of internal wall assembly alternatives focusing on circular design for introducing them to the Belgian construction market.

This study also compares the environmental impacts of internal wall panels using the LCA method. The study's main aim is to select the ideal internal wall panel option having less effect on the environment to be used for the restoration process of the Sumerbank Kayseri Textile Factory building. The building is part of Sumer Bank Kayseri Textile Factory settlement, the first industrial site in Turkey, and a protected heritage site, which now serves as Abdullah Gul University (AGU) Sumer Campus. The factory settlement was opened in 1935 and used as a textile factory until the 2000s. Then it started to be used as AGU Sumer Campus by changing its function after the 2010s. The campus houses newly constructed and historically significant buildings, which have been restored to meet the functional changes. Within the campus design principles, AGU has developed policies to follow United Nation's Sustainability Goals, not just for constructing new facilities but also for restoring the buildings, which are a significant cultural heritage (AGU, n.d.). Therefore, examining the materials used for the ongoing restoration process of the factory building can contribute to the campus's existing and future construction practices in compilation with the university's environmental agenda.

The restoration of the factory building, which is the case of this study, began with strengthening works due to the static test results that showed the vaults did not have sufficient structural strength and stability. During the restoration process, first, shear walls were built between the vaults to strengthen the structure. Then, internal wall panels were used to cover these shear walls to get smooth surfaces. Since the total surface area is so large, the environmental impact of the panels for this application was of great importance when the sustainability concerns of the university and construction practices were considered. Therefore, within the context of this study, LCA analyses of three different internal wall panel options were performed as a case study to select the ideal one regarding overall life cycle impacts. The SimaPro software was used for the LCA analyses, focusing on cradle-to-grave system boundary and using the ReCiPe method with EcoInvent Database. First, the required data for the life cycle impact assessment (LCIA) were collected from internal wall panel producers and sellers based on a detailed market analysis. Then, gathered data were used for the LCIA analyses conducted with the SimaPro software to get the environmental results for internal wall panel options. Finally, results were compared and interpreted according to the damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method.

2. Material and Method

2.1. Life Cycle Assessment Method

The LCA is a scientific method used worldwide, defined, and standardized in the International Organization for Standardization (ISO) 14040 series. The term "life cycle assessment" (LCA) refers to a methodology used to calculate and evaluate the environmental impacts associated with a product's life cycle (Rebitzer et al., 2004). It provides compiling and analyzing the inputs, outputs, and potential environmental impacts of a product system throughout its life (British Standards Institution, 2006). It ensures calculating the environmental impacts of any goods or services during the life cycle phases of raw material acquisition, manufacturing, transportation, production, use, maintenance, disposal, and recovery to find the source of the environmental consequences (British Standards Institution, 2006). In addition, the LCA method can guide the designing of a new product, help choose between similar products, services, and processes, and support determining parameters related to product development (Cooper & Fava, 2006). It is also used as a decision support tool due to being an analytical approach for optimizing the environmental sustainability of a product, service, or system (Grant & Macdonald 2009). When it is conducted during the early design process, it provides improvement of goods and services, which is one of the significant goals of LCA applications (Khasreen, Banfill, & Menzies, 2009; Marsh, 2016; Rebitzer et al., 2004).

Four primary stages of the LCA method are "goal and scope definition," "inventory analysis," "impact assessment," and "interpretation" (British Standards Institution, 2006). At the beginning of an LCA study, first, the goal and scope of the study should be defined. The goal of an LCA study identifies the intended use, the justifications for conducting the study, the target audience, and other details like whether it is used for comparative studies. On the other hand, the scope of an LCA study covers the product system(s), functions of the product system(s), the system boundary, functional unit, allocation procedures, impact categories, required data, assumptions, limitations, and type of critical review. Later, inventory analysis is conducted, which covers data collection and data calculation processes for quantifying related inputs and outputs. Then, the life cycle impact assessment (LCIA) phase is performed to evaluate the significance of potential environmental impacts. In this process, environmental impact categories and category indicators are used for the assessment. Finally, the gathered results are interpreted. This interpretation phase combines the inventory analysis and impact assessment results. The results of the interpretation phase should reach conclusions, explain constraints, and offer recommendations while also being consistent with the goal and scope that have been established (British Standards Institution, 2006; Horne, 2009; Khasreen, Banfill, & Menzies, 2009; Rebitzer et al., 2004).

2.2. Life Cycle Assessment Software: SimaPro

In order to conduct an LCA study, many software has been developed (Ozdemir, 2019). LCA software gives different outputs using different methods and databases. Many environmental results can be obtained using LCA software to assess and manage environmental consequences. The SimaPro is one of the most commonly used LCA tools developed by PRé. It collects and analyses data in the scope of environmental impacts to reveal the performance of a product or company. It is used by many companies and organizations worldwide for various applications such as sustainability reporting, carbon and water footprint, product design, and environmental product statements. The SimaPro has a variety of databases that are constantly updated. As a result, it has an extensive and comprehensive database on various subjects such as agriculture, food, energy, materials, and transportation (PRé Sustainability, 2021, 2022).

The SimaPro software has thirteen methods that can be used for LCA analyses, and these methods have been developed according to different characteristics at global and regional levels. The ReCiPe is one of these methods, which provides characterization factors that represent a global rather than European scale while retaining the possibility of applying characterization factors for several impact categories at a country and continental scale developed for life cycle impact analysis (Huijbregts et al., 2016). The primary property of the ReCiPe method is to convert long-life cycle inventory results into a limited number of indicator scores. ReCiPe indicators are determined in two levels, with eighteen midpoint indicators defined as problem-oriented and three endpoint indicators defined as damage-oriented. Consistency in developing midpoint and endpoint models is increased by working across the various impact categories with the same time horizon per cultural perspective (Acero et al., 2016). The midpoint and endpoint indicators are described as characterization, normalization, damage assessment, and weighting. In the characterization results, many effects, such as global warming, water use, land use, and climate change, can be evaluated. Within the scope of the damage assessment, human health is expressed as the number of years of life lost and the number of years lived disabled. At the same time, ecosystems represent the loss of species over a specific area during a particular time. In addition, the resource is expressed as the surplus costs of future resource production over an infinitive time frame. The normalization impact category compares indicator results with a reference or normal value. Weighting allows weighting between impact categories by multiplying the impact or damage category indicator results with weighting factors and adding them to obtain a total or single score (Huijbregts et al., 2016).

3. Life Cycle Assessment of Internal Wall Panels

Different wall panel types with various features are used for architectural details in the building materials industry. Furthermore, depending on the raw materials and additives used in the production process of wall panels, they are developed for different conditions, such as interior and exterior use. Therefore, the most used internal wall panels were first selected from the Turkish building material industry for the Sumerbank Textile Factory restoration process case. Then the LCA framework was designed to conduct targeted LCA analyses.

3.1. Internal Wall Panel Alternatives

The wall panels used to cover an area may have gypsum and cement content of various types. Therefore, different gypsum and cement-based panels are developed to meet different needs. Furthermore, additives enhance basic cement-based and gypsum panels to obtain reinforced panels. Thus, within the scope of this study, LCA analyses of gypsum, reinforced gypsum, and cement-based panels were performed using their characteristics and properties of raw materials, weightings, and sizes. These properties are defined as follows (Table 1):

- The gypsum panels contain hemihydrate, water, paper liner, and additives as raw materials. The raw materials include 50% and 60% of calcium sulfate, 35% and 45% of water, and paper in up to 5% ratios. It is produced in 12.5 mm thickness and 120 cm x 240 cm width and length, with a unit weight of 8 kilograms.
- The reinforced gypsum panels include gypsum, fiberglass, and binder silicone as the raw materials. One panel's average raw material ratios are 60% calcium sulfate, 30% perlite, 10% calcium carbonate, and 0.1% silicone. It has a 12.5 mm thickness with 120 cm x 240 cm panel dimensions and a unit weight of 11 kg.
- The cement-based panels involve raw materials such as cement, fillers, cellulose, and mica. A reinforced gypsum panel contains 40% and 60% cement, 20% and 30% fillers, 10-15% mica, and 8% and 10% cellulose. It is 1 mm thick and 125 cm x 250 cm panel dimensions with having 13 kg unit weight.

Table 1. Properties of selected internal wall panel options

Panel Options / **Properties**	Gypsum Panel	Reinforced Gypsum Panel	Cement-Based Panel
Raw materials	hemihydrate, water, paper liner, additives	gypsum, fiberglass, and binder silicone	cement, fillers, cellulose, mica
Thickness (mm)	12.5	12.5	12
Width x Length (cm)	120 x 240	120 x 240	125 x 250
Weight (kg)	8	11	13

3.2. Life Cycle Assessment Framework

The goal of the LCA study is to select the ideal internal wall panel option for the Sumerbank Kayseri Textile Factory building restoration process through a comparative analysis for meeting the environmental targets of the university in which the building is part of its main campus. Within the scope of the case study, the cradle-to-the-grave system boundary was selected for the LCA, which provides estimating environmental impacts from product source to disposal (McAlister & Horne, 2009). Since the ReCiPe method is chosen for the LCIA, damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method were compared and interpreted, focusing on human health, ecosystems, and resources impact categories. The data for the selected internal wall panels were first gathered from internal wall panel producers and sellers for inventory analysis. Then, the obtained data was arranged according to the requirements of the SimaPro software by making the required calculations. For this purpose, it was decided to perform an analysis on a standard measurement reference to make a precise assessment, and the size of 1 m^2 was taken as the reference to convert the data for each panel, as shown in Table 2 and explained below:

- The weight of a 1 m^2 gypsum panel is calculated as 2.77 kg, while a reinforced gypsum panel is 3.1 kg, and a cement-based panel is 4.16 kg.
- The produced waste due to the application of a 1m^2 panel was calculated as 5.23 kg for the gypsum panel, 7.19 kg for the reinforced gypsum panel, and 8,84 kg for the cement-based panel.
- The market analysis assumed that the gypsum panel is transported from 317 km, the reinforced gypsum panel from 700 km, and the cement-based panel from 500 km from the factory to the construction site.
- It is assumed that the storage area is 1 km away from the construction site.
- The distance between the construction site and the landfill area, directed by the municipality, is 35.1 km.

Then, for the LCIA, calculated and arranged data were entered into SimaPro software, and also some data were taken from the EcoInvent Life Cycle Inventory (LCI) Database's library. After the data input, the LCIA analyses of selected internal wall panels were performed using the ReCiPe method. Finally, the gathered results were compared and interpreted to define the ideal internal wall panel option within the scope of the case study.

Table 2. Data used for LCA of selected internal wall panel options

Properties / **Panel Options**	Gypsum Panel	Reinforced Gypsum Panel	Cement-Based Panel
Width x Length (cm)	100 x 100	100 x 100	100 x 100
Weight (kg)	2.77	3.1	4.16
Waste (kg)	5.23	7.19	8.84
Transportation from the factory to the storage area (km)	317	700	500
Transportation from the storage area to the site (km)	1	1	1
Transportation from the site to the landfill area (km)	35.1	35.1	35.1

3. Findings and Discussion

LCIA analyses of the selected internal wall panels provided various results for the damage assessment, weighting, normalization, and midpoint and endpoint data of the characterization results defined by the ReCiPe method. Therefore, damage, weighting, and characterization results were used for the interpretations since normalization results provided similar results to the weighting scores.

When the damage assessment results are compared and interpreted, it is seen that the differences between the selected internal wall panels are very low (Figure 1). However;

- For the human health endpoint impact category, the reinforced gypsum panel has the highest impact, followed by the gypsum panel. Finally, the cement-based panel has the lowest result.
- For the ecosystems endpoint impact category, the reinforced gypsum panel has the highest impact, followed by the cement-based panel, and the gypsum panel ranks third.
- For the resources endpoint impact category, reinforced gypsum and cement-based panels have identical results, and the gypsum panel follows them.
- According to endpoint impact assessment results, it can be said that the reinforced gypsum panel has the highest impact for all categories. This is because many additives are used to produce the reinforced gypsum panel to increase its performance against water and humidity. Moreover, the distance required for transporting the reinforced gypsum panels from the factory to the storage area in the construction site is the highest. Therefore, it can be inferred that as the additives used and their usage ratios increase, and the distance for transportation increases, they may cause an increase in the direct harmful effects on the environment.
- According to these results, it can also be said that the ideal panel selection regarding human health is the cement-based panel due to having the lowest results for all categories. This result may be because the number of raw materials and the additive ratios of the cement-based panel have been less than the other panels.

The weighting results clearly distinguish between the damage categories, as seen in Figure 2. According to these results;

- All of the endpoint impact categories show very close results in themselves. However, all panels have higher results than others for the human health category. While the resources category takes second place, the ecosystems category follows it by a very small difference.
- The human health endpoint impact category is related to the midpoint impact categories of fine particulate matter formation, ozone formation, ionizing radiation, stratospheric ozone depletion, carcinogenic and non-carcinogenic human toxicity, global warming, and water use (Huijbregts et

al., 2016; PRé Sustainability, 2022). Therefore, as it is seen in the damage assessment results, the dust-formed raw materials and water consumption required for the production of panels, the particulates produced during raw material acquisition and production stages, and the emissions created during raw material acquisition, production, and transportation phases may cause this result.

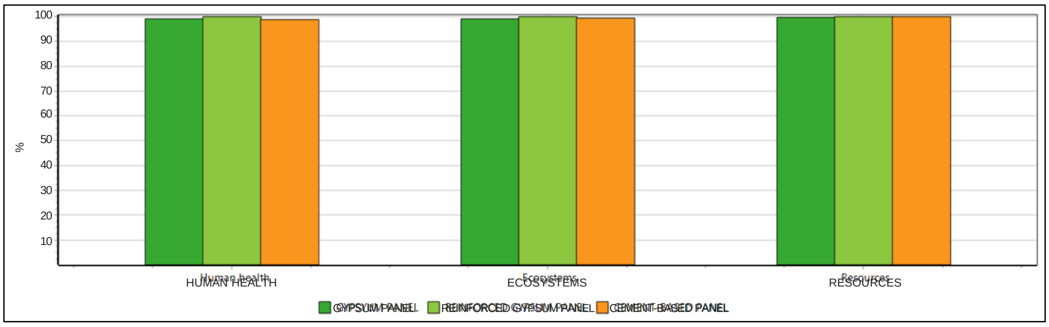


Figure 1. Damage assessment results for the selected internal wall panels

- The resources endpoint impact category is related to the midpoint impact categories of global warming, water use, freshwater ecotoxicity, freshwater eutrophication, ozone formation, terrestrial ecotoxicity, terrestrial acidification, land use, marine ecotoxicity, and marine eutrophication (Huijbregts et al., 2016; PRé Sustainability, 2022). When all of these midpoint impact categories are considered, it can be interpreted that due to the similarities in raw material acquisition, production, and construction stages, as also the transportation requirements, all panels can have the same results for the resources category.
- The ecosystem's endpoint impact category is related to the midpoint impact categories of mineral and fossil resource scarcity (Huijbregts et al., 2016; PRé Sustainability, 2022). Resembling the resources category, having similar properties for the life cycle phases, may cause this result.

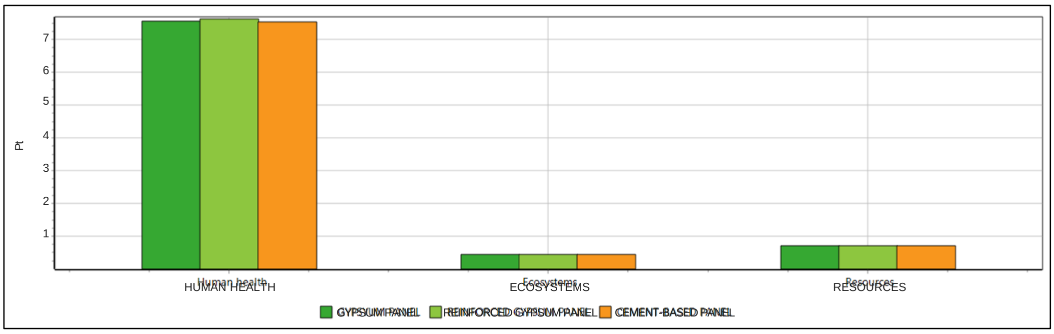
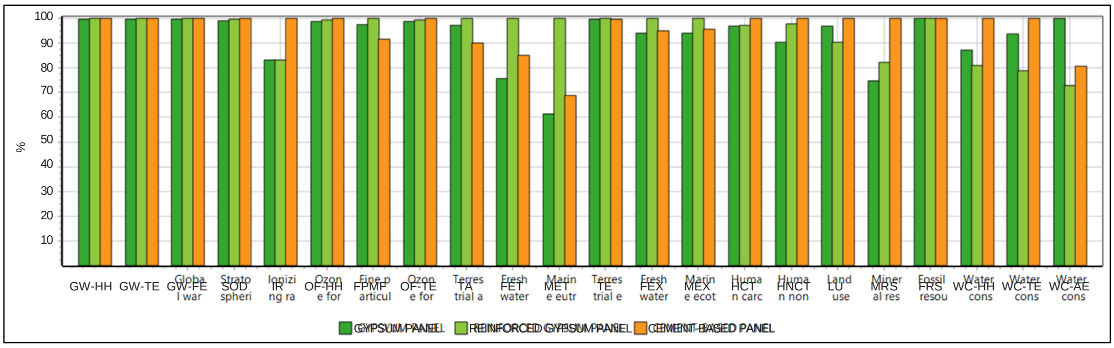


Figure 2. Weighting results for the selected internal wall panels

The characterization results show the role of various midpoint impact categories in detail, as seen in Figure 3. While most midpoint impact category results are the same or almost identical for all panels, some show differences. According to these results;

- The human health midpoint impact categories of ionizing radiation, fine particulate matter formation, carcinogenic and non-carcinogenic human toxicity, and water consumption; resources midpoint impact categories of terrestrial acidification, freshwater eutrophication, marine eutrophication, freshwater ecotoxicity, marine ecotoxicity, land use, and water consumption related to terrestrial ecotoxicity and aquatic ecosystem; and ecosystems midpoint impact category of mineral resource scarcity results have differences for all panels.
- Ionizing radiation and fine particulate matter formation occur due to the emissions and air pollution created. On the other hand, terrestrial acidification, freshwater eutrophication, and marine eutrophication impacts are the results of emissions to water or soil. Moreover, carcinogenic and non-carcinogenic human toxicity, freshwater, and marine ecotoxicity are related

to the emission of a chemical (Huijbregts et al., 2016). The results of these midpoint impact categories are strongly connected with the number and amount of raw materials in the dust form and the amount of chemicals they include. Also, the emissions occur during the transportation, production, and construction phases and while applying end-of-life scenarios.



GW-HH: Global warming-human health; GW-TE: Global warming-terrestrial ecosystem; GW-FE: Global warming- freshwater ecosystem; SOD: Stratospheric ozone depletion; IR: Ionizing radiation; OF-HH: Ozone formation-human health; FPMF: Fine particulate matter formation; OF-TE: Ozone formation-terrestrial ecosystem; TA: Terrestrial acidification; FET: Freshwater eutrophication; MET: Marine eutrophication; TE: Terrestrial ecotoxicity; FEX: Freshwater ecotoxicity; MEX: Marine ecotoxicity; HCT: Human carcinogenic toxicity; HNCT: Human non-carcinogenic toxicity; LU: Land use; MRS: Mineral resource scarcity; FRS: Fossil resource scarcity; WC-HH: Water consumption- human health; WC-TE: Water consumption-terrestrial ecotoxicity; WC-AE: Water consumption-aquatic ecosystem

Figure 3. Characterization results for the selected internal wall panels

- Water consumption impacts human health, terrestrial ecotoxicity, and aquatic ecosystem occurs due to a reduction in freshwater availability which can result in the loss of species and diversity. Besides, land use can cause loss of habitat and soil disturbance (Huijbregts et al., 2016). Furthermore, water is one of the primary raw materials required to produce the selected internal wall panels. Therefore, these midpoint impact categories are also directly related to the number and number of raw materials needed to produce a 1 m^2 panel, which varies for all panels.
- Mineral resource scarcity is directly related to the mineral resource consumption that causes natural resource scarcity (Huijbregts et al., 2016). According to the mineral resource scarcity midpoint impact results, the cement-based panel has the highest score, followed by the reinforced gypsum panel, and the gypsum panel ranks last. These results are explicitly gathered due to the mineral-based raw materials cement-based panel has and mineral-based additives required for reinforced gypsum panel.

4. Conclusion and Suggestions

Within the scope of the study, the selection process of an ideal internal wall panel option having less effect on the environment was performed using the LCA method as a case study considering the restoration process of the Sumerbank Kayseri Textile Factory building. LCA analyses were conducted using the SimaPro software and focusing on cradle-to-the-grave system boundary, and the ReCiPe method with the EcoInvent Database was chosen for the LCIA. A significant number of data was collected from raw material usage rates to waste production amount and transportation distances for a comparative LCA analysis. The LCIA results were gathered based on the damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method.

According to the overall results, even though they have different results for the various impact categories, the reinforced gypsum panel is the most harmful to human health, ecosystems, and resources. Cement panels and gypsum panels, respectively, follow it. Based on the defined conditions of the case study, the type of raw materials and additives reinforced gypsum panel requires for the production, and specifically, the total transportation distance of this panel, may affect the results. The cement-based panel also has a similar characteristic but less transportation distance, making it the second. On the other hand, the gypsum panel requires less raw material as the amount, and its transportation distance is also less than the others; therefore, it ranked as the less harmful internal wall panel to the environment within the study's context.

As a consequence, the conducted LCA analyses have enabled making interpretations using environmental impact categories that focus on the life cycle stages of interior wall panel options. In this context, the obtained results supported selecting the ideal interior wall panel to meet the environmental performance target of the Sumerbank Kayseri Textile Factory building restoration process. Furthermore, as the case building is now part of a university campus with environmental targets, it is seen that the LCA method, one of the tools used in environmental management, can potentially lead to new studies. Finally, it can be stated that LCA analysis should be part of the material selection process in order to consider the environmental outcomes of buildings for making optimal decisions related to environmental performance.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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