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A WEB-BASED LIFE CYCLE ASSESSMENT PLATFORM FOR IMPORTED TIMBER PRODUCTS

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ABSTRACT: Under the dual pressure of increasing housing demand and carbon reduction commitments, the greater use of timber has been proposed as a solution for Irish construction. To help promote timber construction in Ireland from a sustainability perspective, this research develops a new web-based platform for life cycle assessment (LCA) for imported timber products, which is currently lacking. By integrating trade data from the UN Comtrade and environmental data from the ECO Portal, this platform supports customised LCA for various imported timber products to a designated country, not only Ireland. During customised LCA, the cradle-to-gate global warming potential (GWP) values are generated and can be visualised in both table and graphical forms and the results and associated metadata can be downloaded in CSV format for further analysis. Under the condition of selecting multiple products, this platform also allows for the comparison between selected products to assist the decision-making process of timber product procurement. Moreover, data quality indicators are provided with both the results and environmental data, including time and geographical representativeness. In the future, the platform will incorporate more LCA databases and encompass more LCA modules related to embodied carbon assessment and domestically manufactured timber products will be supported as well.

KEYWORDS: timber, life cycle assessment (LCA), Ireland, embodied carbon, web-based LCA tool

1 – INTRODUCTION

To address the dual challenges of increasing housing demand and greenhouse gas (GHG) reduction commitments, increased use of timber has been proposed as an easily implemented solution for Irish construction. However, as Song et al. (2025) noted, timber frame only accounts for 24% of the housing market in Ireland [1]. The reason behind this low value is multifaceted. Besides general concerns or perceptions (e.g., on strength and durability) limiting timber use, the regulatory barriers and the long tradition of utilising masonry in Irish construction are challenges to promoting timber [2]. Although a lot of research has identified lower environmental impacts of building with timber (e.g., [3]), the incomplete life cycle assessment (LCA) for Irish wood construction could discourage the confidence of building designers and relevant stakeholders in demonstrating the environmental benefits of timber. After a comprehensive review of LCA practices for wood construction worldwide, Song et al. (2025) concluded that the main gap in LCA for Irish wood construction could be the lack of localised lifecycle inventory (LCI) data for wood products used in the Irish market [1]. The construction wood products manufactured in Ireland primarily consist of sawn timber, medium-density fibreboard (MDF), and oriented-strand board (OSB), collectively accounting for 30% of the annual harvested Irish softwood [1]. Additionally, a substantial amount of wood products are imported annually, such as plywood and particleboard. In recent years, cross-laminated timber (CLT) and glue-laminated timber (Glulam) have been gradually adopted in Irish construction, and they also depend on import due to the lack of manufacturers in Ireland for now.

Regarding the LCI data for Irish timber products, the primary sources are the EPD Ireland database [4] and the generic LCI database by the Irish Green Building Council (IGBC) [5]. In EPD Ireland, environmental product declarations (EPD) for Irish-produced MDF and OSB are already in place. The Forest Industry Ireland (FII) developed EPDs for different types of sawn timber manufactured in Ireland [6]. In terms of imported timber products, IGBC provides their reference global warming potential (GWP) values in the generic LCI database, but

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these values are sourced from the UK Wood for Good database and the ICE (inventory of carbon and energy) database, which may lead to deviations from the Irish context [5]. Therefore, the customised LCI data for Irish-imported timber products needs to be developed.

Unlike preparing an EPD for a specific product, the LCA for imported products is usually conducted based on multiple existing EPDs as the same imported product type could contain products produced by various manufacturers from various regions. In such a case, determining which EPDs to use as a basis becomes a key decision. The decision process generally commences with identifying primary manufacturers of the imported product type. Subsequently, consultation is undertaken with the manufacturers to obtain EPDs. Finally, the environmental impacts of the imported product are computed as a weighted average of these EPDs according to manufacturers' contribution to the total trade quantity. The whole process requires a significant input of time and manpower, but accordingly, the generated LCA results are more trustful and convincing. An example is the "2024 embodied carbon data for timber products" developed by Timber Development UK, which provides A1-A4 (as defined in EN 15978 (2011)) GWP values for 10 timber product types [7].

Nevertheless, the substantial investment of time and manpower in LCA for imported products lead to delayed results. Given that all EPDs are required to update after a five-year validity period, subsequent updates of LCA results for imported products pose a tough challenge. Furthermore, although the business between manufacturers and building contractors generally remains stable over long periods, the trade data could still fluctuate annually. Consequently, during computation of the weighted average environmental impacts of EPDs, the weighted factors of various manufacturers could change for different period considerations. This poses another challenge for future updates of LCA results for imported products.

Therefore, this research proposes a new web-based LCA platform that allows automatic LCA updates for imported timber products by linking actual trade data and LCA/EPD databases. The objective and dependent methodology of this platform are introduced in Section 2 and Section 3, respectively. An LCA case study of Irish-imported timber products is also presented in Section 3 using this platform. The innovations and limitations of this platform are discussed in Section 4, followed by the conclusions and future work in Section 5.

2 – OBJECTIVE

Aiming to develop an LCA platform for imported timber products, the Irish context is selected as the starting point for determining the timber product types covered. According to the CSO WPEI03 database, the top three categories of imported timber products with significant values in 1995-2022 are "secondary wood products", "veneer sheets and wood-based panels", and "coniferous sawnwood" [8]. Then eight types of timber products are initially targeted based on the definition of these three categories [9], including CLT, Glulam, plywood, particleboard, OSB, MDF, HDF (high-density fibreboard), and sawnwood. It is worth noting that the coniferous and deciduous wood is not distinguished in this research as the wood species information is not stored in the digital environmental data.

Regarding LCA for the timber product types covered, GWP is selected as the environmental impact indicator in the current version of this LCA platform. This is because GWP is an indicator commonly considered for estimating environmental impacts of construction projects in the past two decades [10]. Moreover, only the GWP of the production stage (Figure 1) is included in this platform for now due to the following reasons. (1) First, modules A1-A3 are compulsory in all EPDs and some EPDs could miss modules beyond A1-A3. (2) Second, modules A1-A3 are the primary consideration by many generic LCI databases [1], including the generic LCI database by IGBC. (3) Third, for timber products, the worldwide LCI data richness is still low [1] and the inclusion of modules beyond A1-A3 requires more user-customised inputs. For example, the environmental impact estimation of module A4 for Irish-imported plywood requires transportation modelling from each trade partner to Ireland, and it needs consultation with each plywood manufacturer. Similar workloads are also required for the inclusion of other modules, like the end-of-life (EoL) stage (Figure 1). Therefore, for now, including modules beyond A1-A3 will pose a great challenge for users and reduce the automation level of this platform.

To conclude, the proposed web-based LCA platform helps users estimate the GWP of modules A1-A3 for designated imported timber products. By automatically linking the up-to-date trade data and LCA/EPD databases, this platform requires few user inputs and supports automatic updates in subsequent stages.

3 – METHODOLOGY

3.1 USER INPUT

Besides product type, this platform allows users to customise the other four parameters, including the country name, trade period, environmental data source, and environmental data valid until year, as shown in Figure 2. The country name indicates the country importing timber products and the trade period represents the years for fetching trade data. The environmental data source helps designate the LCA/EPD databases for fetching environmental data. Finally, the environmental data valid until year is the year until which the data must be valid.

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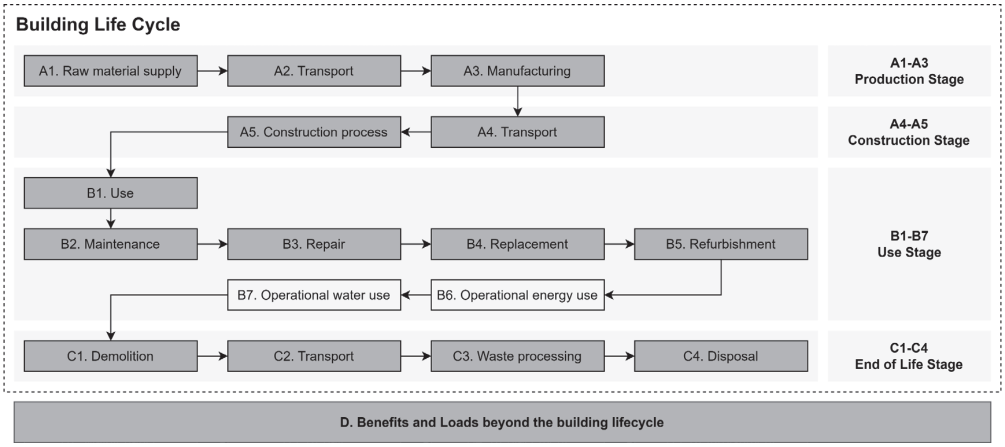

Figure 1. LCA modules defined in EN 15978 (2011) [11] *(shaded modules are relevant to embodied carbon)*

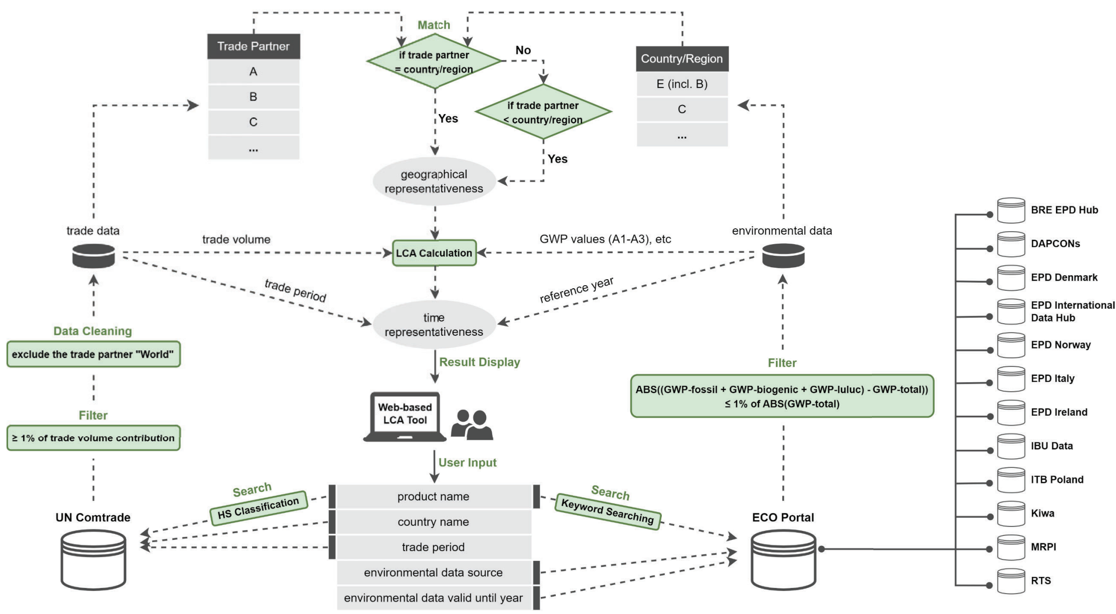

Figure 2. Framework of the web-based LCA platform

3.2 DATA EXTRACTION AND FILTRATION

According to the user input, this platform will fetch trade data and environmental data from the UN Comtrade database [12] and the ECO Portal [13], respectively. The UN Comtrade database is selected due to its timeliness and comprehensiveness for trade data. For now, the ECO Portal is selected as the initial environmental data source as it links with multiple EPD programme operators (Figure 2) and contains nearly twenty thousand data entries. More environmental data sources are expected to be integrated in the future.

In Figure 2, data processing steps are marked with green and data transfers are shown in arrows, where dashed arrows mean that transfers are not observable to users.

For fetching trade data, product name, country name and trade period are transferred to the UN Comtrade database, where the product name is converted to its corresponding Harmonised System (HS) code for searching. Table 1 shows HS codes for covered timber products based on the HS classification 2022 [14]. After searching, the trade partners with less than 1% of contribution to the total trade volume are first filtered out. Next, the trade partner "World" is excluded from the trade data as its trade volume merely indicates the sum of volume by all trade partners.

Table 1. HS codes for searching trade data

Product Name	HS Code
CLT	441882

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Glulam	441881
Plywood	4412
Particleboard	441011
OSB	441012
MDF	441112, 441113, 441114
HDF	441192
Sawnwood	4407

For fetching environmental data in the ECO Portal, the keyword searching method is adopted, and keywords for various product names are listed in Table 2. Considering that data in the ECO Portal could be in various languages, keyword searching will be conducted in all languages included in the ECO Portal for a product type. At the same time, the environmental data valid until year is employed for the filtration of invalid environmental data. In the ECO Portal, EPD is the primary type for environmental data and all EPDs are stored in a structured digital format [15] – ILCD+EPD (International Reference Life Cycle Data System + EPD) format. The ILCD+EPD format was developed on the foundation of the ILCD format, a format proposed by the European Commission for the documentation of LCA data [16]. Thanks to the ILCD+EPD format, environmental data is extracted and processed in bulk, improving data processing efficiency.

Table 2. Keywords for searching environmental data

Product Name	Searching Keyword (English Version)
CLT	clt, cross laminated timber, x-lam
Glulam	glulam, glue laminated timber
Plywood	plywood
Particleboard	particleboard, particle board
OSB	osb, oriented strand board
MDF	mdf, medium density fiberboard, medium density fibreboard
HDF	hdf, high-density fiberboard, high density fibreboard
Sawnwood	sawnwood, sawn wood, sawn timber

For a product type, the keyword searching will be in 11 languages including English, Danish, German, Spanish, Finnish, French, Italian, Dutch, Norwegian, Portuguese, and Swedish.

While developing this platform, it was found that some extracted GWP values could be problematic. As shown in Figure 2, a filtration rule is defined to exclude the problematic data. When the difference between the GWP-total and the sum of three GWP sub-indicators is larger than 1%, the data is identified as problematic and excluded from subsequent computation.

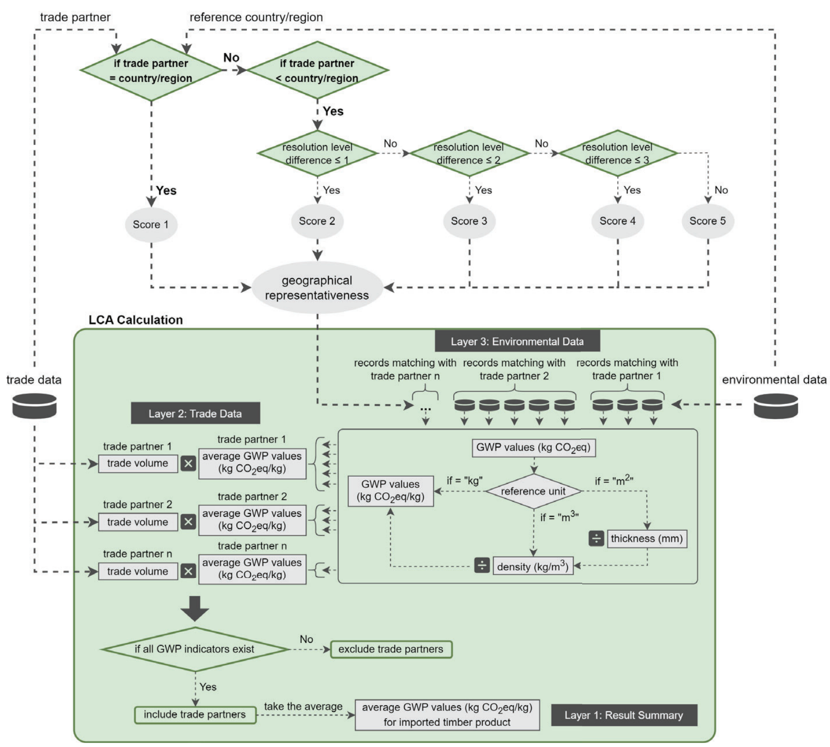

Figure 3. The process of LCA calculation & estimation of geographical representativeness

3.3 LINKING TRADE DATA AND ENVIRONMENTAL DATA

After data extraction, there are two parameters in the trade data – trade partner and trade volume, where the former indicates the country from which timber products are imported, and the latter shows the corresponding trade volume in kg. Various parameters are recorded in the environmental data, including EPD name, reference unit, reference country/region, GWP values, etc. To link trade data and environmental data, the environmental data is browsed to identify matchable records for each trade partner, and matching rules are a hierarchical judging process (Figure 2). For each trade partner, the environmental data is first searched for records in which the reference country/region is the same as the trade

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partner. In the case where no records are available, the second round of searching looks for records in which the reference country/region includes the trade partner. Only environmental data satisfying either the first or the second round of judgment could enter the following LCA calculations.

As shown in Figure 3, the LCA calculation process contains three layers and starts with environmental data in layer 3. After the matching process, environmental data is classified into data groups corresponding to different trade partners. For all data records (i.e., EPDs), their units for GWP values are standardised into "kg CO_2eq/kg". During the unit standardisation, the density and thickness of the data-indicated timber product might be required. However, these two properties are not recorded as separate categories in the ILCD+EPD format; instead, they could be recorded in various categories, such as "general comments on data set", "material property", etc. Moreover, most environmental data does not record the product's density and thickness in digital formats. Therefore, this platform automatically browses the original PDF (portable document format) documents of EPDs to fetch these two properties. However, EPD documents belong to multiple EPD programmers, thus they are prepared in different structures, even in different languages. Consequently, the density and thickness cannot be extracted following the same syntax. In this research, the PDF reading and information extraction process is achieved by calling the API (application programming interface) of OpenAI's LLM (large language model). In the case where the density is unavailable, the default value is assigned according to the softwood density defined in the ICE database V4.0 [17]. However, since it is impossible to specify a default value for the thickness, the current platform would exclude environmental data with the reference unit as "m^2" if the thickness property is unavailable from the PDF format of EPD.

After unit standardisation, GWP values in layer 3 are transferred to layer 2 for computing the GWP of each trade partner. Then, under the condition of all GWP indicators existing for trade partners, the trade volume contribution is multiplied for each partner to compute the average GWP of the studied timber product in layer 1.

3.4 DATA QUALITY CALCULATION

To evaluate the quality of GWP values in environmental data for the studied timber product, two data quality indicators are defined in Table 3, where score 1 represents the best performance. As EN 15804+A2 (2019) requires, environmental data (i.e., EPD) in layer 3 declares data representativeness in terms of time, geography, and technology [18]. However, the data quality system in EPDs cannot be applied here as it evaluates the quality of environmental impacts generated in EPDs. The data quality system in Table 3 is designed to evaluate the representativeness of EPDs extracted in layer 3 for the timber product studied in layer 1. The technological representativeness is excluded as it is not assessable due to the absence of technological attributes for the timber product in layer 1.

Table 3. Data quality system

Score	Time Representativeness	Geographical Representativeness
1	The represented year of environmental data falls within the time coverage of trade data	Environmental data is from the same trade partner under study
2	The difference between the represented year of environmental data and the trade data period is less than 2 years	Environmental data is from a broader geographical level including the trade partner under study AND the difference is within 1 level of resolution
3	The difference between the represented year of environmental data and the trade data period is less than 4 years	Environmental data is from a broader geographical level including the trade partner under study AND the difference is within 2 levels of resolution
4	The difference between the represented year of environmental data and the trade data period is less than 6 years	Environmental data is from a broader geographical level including the trade partner under study AND the difference is within 3 levels of resolution
5	The difference between the represented year of environmental data and the trade data period is larger than 6 years OR not accessible	Not accessible

Geographical levels: A-global, B-continental, C-sub-region, D-national [19]

In Table 3, the time representativeness is determined by the difference between the represented year of environmental data and the trade data period. The trade data period could be a specific year or a period. In the latter case, both years starting and ending the trade data are used to calculate differences, and the minor difference is adopted. For the geographical representativeness, four geographical levels (i.e., A-global, B-continental, C-sub-region, D-national) are referenced from the classification system by the Statistics Division of the United Nations Secretariat [19]. The score is assigned according to the disparity in resolution level between the trade partner under study and the reference country/region of environmental data. This method is proposed by the US EPA to estimate the geographical representativeness more objectively [20]. Moreover, as explained in the top of Figure 3, the matching of environmental data with trade data is a hierarchical process which prioritises environmental data with better geographical representativeness.

Following the allocation of data quality scores to GWP values in environmental data in layer 3, the scores are transferred to assess the quality of GWP values in layers 2 and 1. The assessment follows a similar methodology to that employed for estimating GWP values in the LCA calculation process.

3.5 RESULT VISUALISATION

Table 4. Output data framework

Layer 1: Result Summary	product name imported country trade period considered trade volume (%) GWP-fossil (A1-A3) (kg CO_2eq/kg) GWP-biogenic (A1-A3) (kg CO_2eq/kg) GWP-luluc (A1-A3) (kg CO_2eq/kg) GWP-total (A1-A3) (kg CO_2eq/kg) time representativeness geographical representativeness number of environmental data used
Layer 2: Trade Data	trade partner trade volume (kg) contribution to total trade volume (%) GWP-fossil (A1-A3) (kg CO_2eq/kg) GWP-biogenic (A1-A3) (kg CO_2eq/kg) GWP-luluc (A1-A3) (kg CO_2eq/kg) GWP-total (A1-A3) (kg CO_2eq/kg) time representativeness geographical representativeness number of environmental data used
Layer 3: Environmental Data	data source data type data/EPD name EPD owner EPD programme reference country/region reference year valid until year reference unit density (kg/m^3) thickness (mm) GWP-fossil (A1-A3) (kg CO_2eq) GWP-biogenic (A1-A3) (kg CO_2eq) GWP-luluc (A1-A3) (kg CO_2eq) GWP-total (A1-A3) (kg CO_2eq) time representativeness geographical representativeness URL EPD PDF

GWP-fossil: GWP related to fossil fuel consumption; GWP-biogenic: GWP related to the sequestration and release of biogenic carbon; GWP-luluc: GWP related to the land use and land use change.

The output data on this web-based LCA platform also contains three layers, and information included in each layer is listed in Table 4. As observed, the GWP and data quality indicators are shared parameters in three layers, and the number of environmental data used is included in layers 1 and 2. Besides, layer 1 includes the studied product name, imported country, trade period, and considered trade volume (%). The first three of these are based on the user input, and the latter one indicates the included trade volume percentage for GWP estimation. Layer 2 includes the trade partner, trade volume and the corresponding contribution to the total trade volume (%). In layer 3, various information is included. In addition to attributes (e.g., data name) of environmental data, the URL (uniform resource locator) and EPD PDF link to the human-readable website and original PDF for an EPD, respectively, with which users could check more information that is not disclosed in layer 3.

The visualisation of output data on this platform is in both table and graphical views (Figure 4). In the graphical view, a pie chart shows significant trade partners and their contributions to the total trade volume, and two bar charts show GWP values for the timber product in layer 1 and GWP values for significant trade partners in layer 2. The table view contains all the information introduced in Table 4 and three layers are indexed hierarchically. As observed in Figure 4, a number of environmental data are highlighted in a red background, signifying data excluded from the LCA calculation. Such data could pertain to problematic data or data with a reference unit of "m^2" but missing thickness information. Displaying excluded environmental data ensures data transparency and enables users to review and revise LCA results. With the "Revise Data" button, users are free to edit environmental data in the table view, and the revision will be automatically applied to update results in both graphical and table view after clicking the "Update" button. The addition and deletion of environmental data can also be facilitated by following similar steps to revision steps.

In addition to estimating GWP values for an imported timber product, this platform supports comparing multiple timber products. For example, in Figure 4, the selection of both CLT and Glulam is possible; graphical representations for multiple products can be switched by clicking the pagination buttons. The GWP comparison function is instrumental in assisting the decision-making process of timber product procurements, particularly when environmental impact is a salient consideration between similar products.

4 – CASE STUDY OF IRELAND

To test the platform, Irish-imported timber products from 2020 to 2024 are targeted, and all the environmental data from the ECO Portal is defined to be valid until 2025. In Figure 5, GWP results are divided into GWP-biogenic and GWP-GHG (i.e., the total GWP excluding biogenic carbon). No trade data is available for MDF. As observed, the initially generated GWP values for Glulam appear anomalous in the overall results. After review, the abnormal value for Glulam is attributable to an erroneous storage of "kg" as the reference unit in the digital format of an EPD, despite "m^3" being declared in its PDF format. Therefore, two rounds of revisions proceed towards the environmental data in layer 3 using the revision and addition functions on the platform. The first revision corrects abnormal attributes in the environmental data, and the second revision tries to check and incorporate the excluded environmental data (i.e., data marked with a red background on the interface) to improve the quality of

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estimated GWP results. In the following content and figures, results before and after revisions are classified by numeric suffixes 1, 2, and 3. Only Glulam and plywood are involved in the first revision. The erroneous reference unit is rectified for Glulam. For plywood, an EPD is found to have a density of 50 kg/m^3 due to the incorrect extraction from the original PDF document.

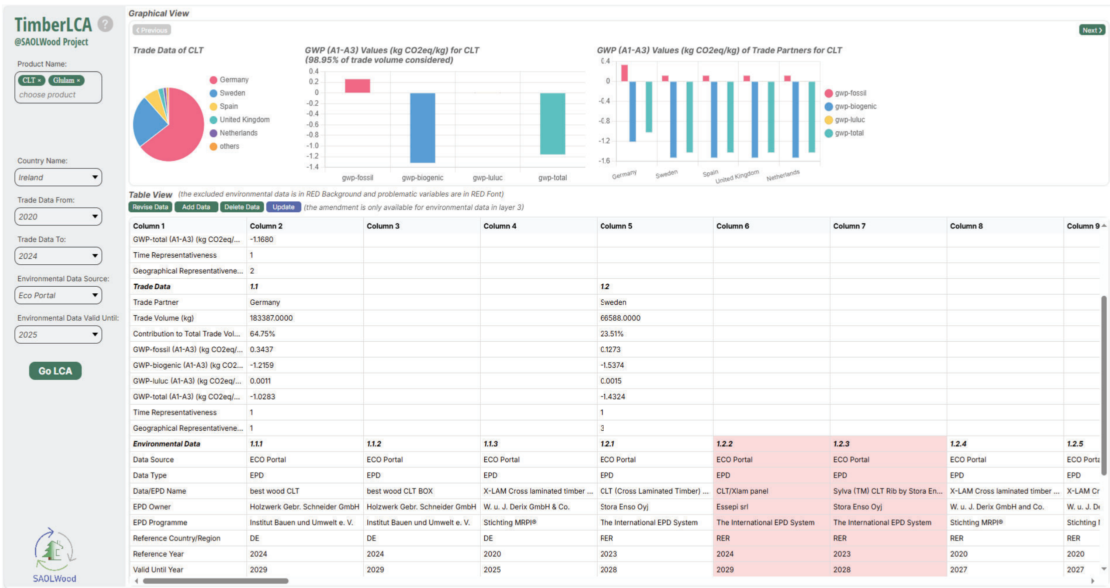

Figure 4. Interface of the web-based LCA platform

Although incorporating more environmental data records, the second revision does not result in significant alterations to the GWP results. For particleboard, OSB, and sawnwood, the results remain unchanged as no extra data is available. Except for these three products, 1 more record is added to CLT, and 2 more are added to Glulam and HDF, respectively. 8 extra records are added to plywood. Figure 6 shows the improvement in quality indicators for the estimated GWP results for CLT, Glulam, plywood, and HDF. The first revision is not included in Figure 6 as all the quality indicators remain the same as the initial results. As observed, the time and geographical representativeness and the considered trade volume for CLT are not improved after adding one more record. While the considered trade volume increases for both Glulam and HDF in the second revision, the representativeness in geography is sacrificed. For plywood, only the time representativeness gets a slight enhancement after considering 8 additional records.

To conclude, the second revision does not significantly enhance the time and geographical representativeness of the GWP results for timber products. However, it reveals challenges waiting to be conquered in the following development of this LCA platform as these additions are from the environmental data that is initially excluded. There are three main reasons for adding back the initially excluded records. First, some information in the digital format of environmental data (i.e., mainly EPD) is incorrect and not consistent with its PDF version. Second, density and thickness are not recorded in the digital format of data, and the extraction process from PDF documents is unstable with OpenAI's LLM. Third, the reference unit of environmental data is not standardised into "m^2" or "m^3". For example, some timber product EPDs adopt "pcs" (i.e., pieces) as the reference unit. Therefore, the data cleaning process of environmental data needs to be improved, and a new data structure may be needed for environmental data for timber products.

Nevertheless, after revision, the platform-generated GWP results for Irish-imported timber products are close to the reference values from the ICE database (Figure 5). The GWP-GHG between the platform-generated result and the ICE result shows a large difference for sawnwood, which is because only one environmental data is used for the estimation. Regarding HDF, no reference value is available in the ICE database. However, the results generated by the platform are reasonable compared to the reference values for MDF. Therefore, the developed web-based LCA platform is verified to be valid for the GWP estimation of Irish-imported timber products.

Figure 5. GWP results for Irish-imported timber products VS reference values in the ICE database

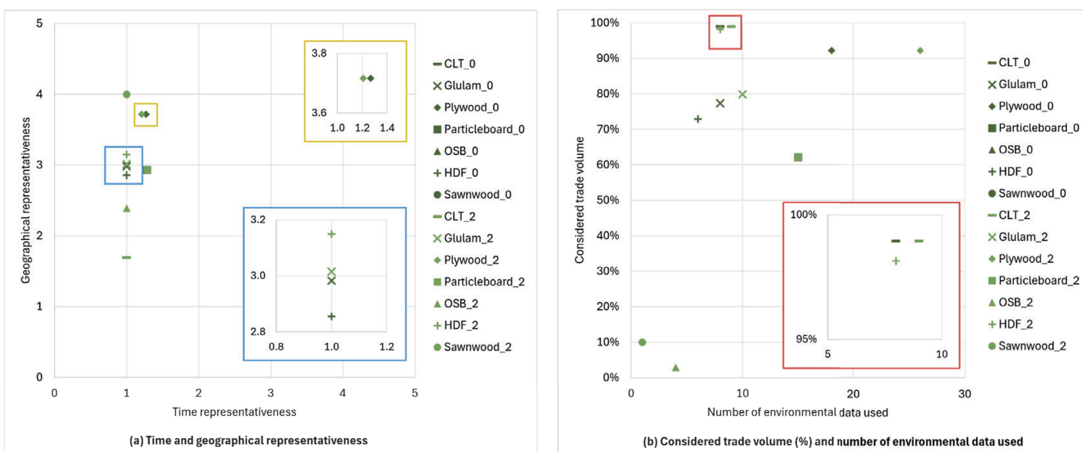

Figure 6. (a) Time and geographical representativeness (left) & (b) Considered trade volume (%) and number of environmental data used (right)

Table 5. GWP results for Irish-imported timber products after the second revision

Product Name	GWP-GHG (kg CO_2eq/kg)	GWP-biogenic (kg CO_2eq/kg)	Considered Trade Volume (%)	Number of Environmental Data Used	Time Representativeness	Geographical Representativeness
CLT	0.27	-1.15	98.95%	9	1.00	1.69
Glulam	0.26	-1.57	79.88%	10	1.00	3.02
Plywood	0.64	-2.00	92.22%	26	1.21	3.72
Particleboard	0.47	-1.47	62.15%	15	1.29	2.93
OSB	0.45	-1.66	2.92%	4	1.00	2.39
MDF	N/A	N/A	N/A	N/A	N/A	N/A
HDF	1.03	-0.97	98.15%	8	1.00	3.15
Sawnwood	0.07	-1.50	9.99%	1	1.00	4.00

N/A: not available; GWP-GHG: GWP excluding the sequestration and release of biogenic carbon; GWP-biogenic: GWP related to the sequestration and release of biogenic carbon

In addition to the graphical demonstration, the finalised GWP results for Irish-imported timber products and corresponding quality indicators are listed in Table 5. As observed, the estimated GWP results for all product types have a satisfactory degree of representativeness in time but not in geography. The good performance in time representativeness is because 2020-2024 is defined as the search scope for trade data. Moreover, the selected EPDs are required to be valid until 2025, thereby ensuring that their reference years easily fall within the trade data period. The unsatisfactory performance in geographical

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representativeness reflects the shortage of country-customised environmental data in the ECO Portal; most timber product EPDs are for broader scopes. Besides, there is insufficient data available in the ECO Portal for OSB and sawnwood, which leads to suboptimal trade volume percentages considered for the GWP estimation.

5 – DISCUSSION

As shown in the case study section, the developed LCA platform successfully estimates the cradle-to-gate GWP indicators for Irish-imported timber products, and the results are reasonable compared to the reference values in the ICE database. However, some challenges are also identified from the results for future work.

5.1 DIGITAL DATA VS PDF DATA

In this research, digital environmental data is the primary source for fetching information as it has been collated into a machine-readable format. The PDF version of EPDs (i.e., PDF data) is used as a supplement for extracting density and thickness. However, in the case study for Ireland, it is found that the digital data sometimes omits or misrepresents certain information that could be available in the PDF data. Therefore, digital data is easier to access than PDF data, but uncertainty exists in the comprehensiveness and accuracy of the information. It is worth noting that even in the PDF data, information comprehensiveness and accuracy are not always guaranteed, but PDF data has a lower probability of recording erroneous information than digital data.

The main challenge for automatically reading PDF data is the unstandardised structure and language of EPDs adopted by different EPD programmes. In existing research, a common method of reading PDF data is using software tools employing Optical Character Recognition (OCR). With the rapid advancement of artificial intelligence (AI) technologies, LLM is widely applied to reading and understanding natural languages. In this research, OpenAI's LLM is called through the official API for the information extraction from PDF data. However, its performance in understanding the EPD's structure and content is still unstable, such as the extraction of abnormal density for the Irish-imported plywood. Therefore, OpenAI's LLM needs to be fine-tuned with pretraining a significant number of environmental data (mainly EPDs). This will be achieved in the future development of the LCA platform.

5.2 CALLING EXISTING DATABASES VS EMBEDDING A CUSTOMISED DATABASE

To dynamically update LCA results, the proposed platform calls the UN Comtrade and existing LCA/EPD databases (only ECO Portal is integrated in the current version of the platform) using API whenever users conduct an automatic LCA. The API calling process usually takes a longer time than calling an embedded database. The processing time could be even longer after adding the PDF reading step. Moreover, embedding an LCA database customised for timber products may improve the platform's performance from other perspectives. However, the potential improvements are companies by prerequisites for the customised database.

First, more environmental data could be considered in the initial LCA for imported timber products if data in the customised database is well classified by timber product types and is equipped with extra information (e.g., density, thickness, etc.) needed for LCA of timber products but beyond what exists in the digital data. In the current platform, environmental data for timber products is fetched by searching the EPD/data name with designated keywords. Some data records could be missed if the keywords (e.g. "sawnwood") are not in their names. However, expanding the keyword list may increase the burden of the subsequent filtration step. Therefore, a well-classified and well-structured database for timber products could reduce the probability of missing data. Second, the timber product types could be further classified with a well-classified database. For instance, the coniferous and deciduous products are able to be distinguished when the timber species information is added to the customised database. Third, more intelligent functions are possible if the customised database is embedded in the form of LLM. To build a customised LCA database for timber products, LLM is an optimal choice for collecting environmental data and extracting information. Therefore, the customised LCA database can be implemented in LLM rather than traditional formats (e.g., SQL (structured query language)). In such a case, more intelligent functions are allowed to develop.

6 – CONCLUSION

In conclusion, this research proposes a web-based LCA platform to estimate GWP indicators in modules A1-A3 for imported timber products. Taking Ireland as a case study, the platform is verified to successfully generate valid and reasonable GWP results for timber products. However, the automation level of this platform is limited, as manual revisions are needed for some products to generate results with higher quality. In addition, as discussed in Section 5, in the future, an LCA database will be developed specifically for timber products to incorporate the existing LCA/EPD databases worldwide and be embedded into this platform in the form of LLM to improve the platform's performance.

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