Description of the Challenge

The challenge put forward is entitled: ***"How to measure and control the environmental impact of industrialised wood construction"***

This challenge addresses the needs described below:

- How can we calculate the real environmental impact of each structural element and infrastructure on the whole?
- How can we align our business plan and positioning with the principles of sustainable development (environmental, economic, and social) and trends outlined by the European Union directives?
- How can we control raw material sourcing and their PEFC and FSC certification?
- How can we control and record wood structural element traceability (CLT and GLT) along with their environmental impact?
- How can we control internal operations and industrial processes for first and second wood processing?
- What new indicators will we need to provide an overview of environmental impact and assist with decision making?
- How can we store and publish relevant information about our products once installed so that it is easily accessible for all stakeholders?

Background

EGOIN is a family-owned business with more than 30 years of experience in **designing wood structural solutions for the construction sector**. Its value proposal includes engineering, design, manufacture, and assembly, making it a trustworthy partner when it comes to developing construction projects such as cover structure and roof refurbishment, high-rise residential buildings, public and private developments, single-family housing, pavilions for sport and industrial use, and more.

Since the first version of the Spanish Technical Building Code (CTE)[1] was published in 2006, which required compliance by 2009, a notable number of new **construction systems** started coming to market in order to comply with these regulatory requirements.

Likewise, the production of support documents to calculate the requirements and creation of new software to simulate and certify buildings represented a step towards specialisation and the development of **new solutions** to satisfy the needs and requirements of the market, not just in terms of benefits (energy efficiency, acoustic performance, fire resistance, durability), but **environmental performance** as well (carbon footprint, embodied energy, toxicity, among others).

In terms of wood production, one of the most impactful improvements noted can be found in **waste** revaluation for sub-product manufacturing: wood conglomerates, wood fibre insulation, pellets, and paper pulp.

[1]Website: https://www.codigotecnico.org/

On the other hand, the exponential growth of real estate activity together with raw material and **labour shortages**, and improved schedules, have resulted in a search for increasingly industrialised solutions that guarantee greater product quality. In turn, this has resulted in solutions that are easier to transport (with **large-format** products) and faster to assemble.

In terms of the sector, the leap in technology has led to the development of laminate pieces in the form of wood panels commonly known as **CLT** (Cross Laminated Timber), and structural **GLT** (Glue Laminated Timber) beam and pillar pieces. These solutions allow for open spaces to be constructed with **large spans** using large-format pieces that result in more efficient use of raw materials on a building level, increased piece quality due to their being entirely factory produced, and a significant reduction in assembly times. In addition, the fact that it is an eco-friendly material means that it is having a major impact on the market.

Illustration 1. CLT (Cross Laminated Timber) building and roof with GLT (Glue Laminated Timber) beams

The trend towards more sustainable building construction is also an important point in the evolution towards more efficient and better quality products that provide economic and social benefits in addition to environmental ones. We should recall the principles and definition of **sustainable development** that came to light for the first time through the *Brundtland* report for the UN[2] in 1987, which was conducted by the *Brundtland Commission* and led by Norway's ex-Prime Minister, *Gro Harlem Brundtland*. This has come to mean development that satisfies current needs without compromising the needs of future generations, which is upheld by three main pillars: environment, economy, and social. Today, 17 sustainable development goals have been adopted through the 2030 sustainability agenda to eradicate poverty, protect the planet, and ensure prosperity for all, and establishing a plan to reach these Goals within 15 years[3].

[2] The United Nations is an international organisation comprised of 51 nations that was founded in 1945 following World War II as a commitment to keep peace and maintain international security, encourage friendly relationships between nations, and promote social progress, improved standards of living, and Human Rights.

[3] Information source: www.un.org/sustainabledevelopment

Illustration 2. Sustainable Development Goals

From here, support guides and tools began to appear that were based on indicators that helped quantify different impacts and establish improvement strategies. It should be noted that the construction sector is one of the most harmful in environmental terms [1].

In 1998, the *LEED* certification appeared in the United States through the *USGBC (US Green Building Council)*[4], and in 1990, the *BREEAM* certification developed by the UK's *BRE Global* organisation[5] was launched in order to quantify and classify buildings in function of their sustainability. Successive modifications arose to adapt requirements to each case according to use (housing, industrial, administrative) or nature (new construction or renovation), particularly when it came to risk prevention and environmental matters. Some of the public administrations joined in and created their own certification tools, such as the "Sustainable Building and Renovation Guides" that are applicable through specific "Gestor ERAS" software[6], launched in 2011. Eco-labels aimed at products such as FSCs and PEFCs also appeared [2] to assist with obtaining certifications[7]. These eco-labels guarantee wood chain of custody, certifying its source.

One of the strong points of "green" certifications can be found in the Building Life Cycle Analysis [3]. These are currently summarised in the collection of Environmental Product Declarations (EPDs) as a standard result on a very general level regarding environmental impact in the form of a carbon footprint for each product, estimating a building's entire carbon footprint. However, given developer demands in terms of product control through to their arrival on site, it can be seen that this document is insufficient due to its very general nature, with the reality of certain cases sometimes being quite different [4]. In addition, complications have been detected when it

[4] Website: https://www.usgbc.org/leed
[5] Website: https://breeam.es/
[6] Website: https://www.ihobe.eus/publicaciones/aplicacion-eras-herramienta-para-aplicar-guias-edificacion-y-rehabilitacion-sostenible-2
[7] Information source: "Practical guide to using environmental certification in public procurement and contracting". IHOBE.

comes to integrating these documents into the building's final model, called “As-Built”, developed with BIM technologies [5].

In this case, as a step prior to calculating a building’s **environmental impact** or LCA (Life Cycle Assessment), **traceability** as a control mechanism in the extraction, processing, manufacturing, assembly, and end-of-life chain becomes particularly relevant when it comes to being in line with the requirements that we face [6]. To do this, it was deemed necessary to design tools and systems that help us record and store information in a way that is easily accessible and transparent for all stakeholders [7].

Likewise, a regulatory change was predicted for product sustainability, along with the creation and appearance of new certification systems called “Digital Passports”. These mechanisms will allow data to be recorded that is associated with the environmental impact assessment of the product's entire life cycle, which will also contribute to the **Circular Economy** [8].

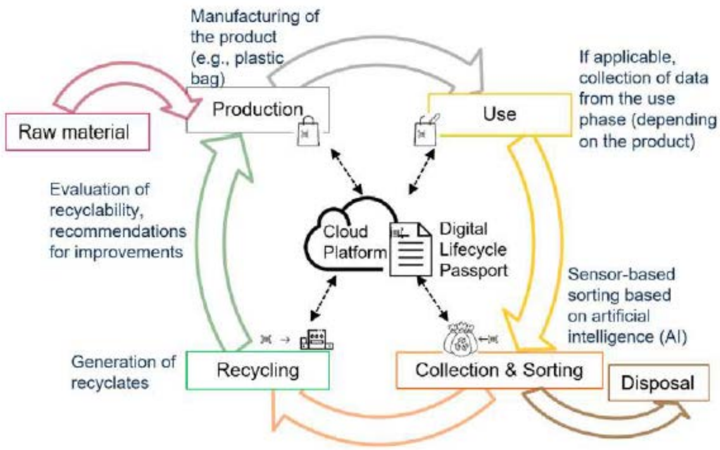

Illustration 3. Digital Passport information storage throughout the Life Cycle

In turn, this strategy involves improved **quality** control that, in our case, is supported by the ISO 9001:2015 standard. Said standard helps us establish a quality management system divided into the following principles: Client focus, leadership, a commitment to individuals, process focus, continuous improvement, evidence-based decision making[8].

EGOIN intends to focus its efforts on characterising the impacts of its products through to the point they arrive on site, with the understanding that this is a priority mechanism for the later improvement and/or development of more innovative and environmentally respectful solutions.

Our commitment to sustainability is a cross-cutting focus found in all of EGOIN’s activities and philosophy. A commitment to the environment is the pillar on which the company’s foundations are built, which goes beyond business opportunities or commercial claims.

When logs reach EGOIN’s facilities, wood is processed to create KVH pieces that are used to produce **light-frame CLT** panels and **GLT** pieces. In this stage is where the engineering team-led design process comes in, where sections are cut down and internal and external material orders

[8] Information source: www.iso.org

are placed. Machining files are prepared, but will not be applied until they are included in manufacturing and assembly planning. Said planning is contingent on planned on-site delivery in order to adjust machining times and immediately release the product once the necessary transportation and assembly resources are managed. This way, mass and extended storage of the finished product are avoided. EGOIN's cycle ends with the completely assembled project's delivery, matching the client's contracted budget.

Given the increased demand for projects and EGOIN's increased productivity, the company has found it necessary to expand their facilities. EGOIN currently has more than 60,000 m2 of productive surface area spread across *EGOIN Natxitua*'s three plants in Ea (Bizkaia), *EGOIN Goain*, and *EGOIN Albertia* in remote sites found in Legutiano (Alava). The three warehouses are organised for coordinated production, weaving together products that can be processed and/or machined in different factories, resulting in a complex production scheme where not all projects follow the same line.

The first wood processing happens in *Goiain*, with board drying and categorising taking place there as well as in *Albertia*. In addition, board supply orders are placed with external suppliers. GLT production is carried out entirely in *Goiain*, while CLT production can be completed at the three factories *(Goiain, Albertia*, and *Natxitua*). In terms of piece machining, CLT can be machined at the three factories, while GLT beams are machined in *Goiain* and *Natxitua*. When it comes to light-frame production, this is carried out entirely in *Natxitua*. In terms of stock, Natxitua reserves batches of wood in board and GLT beam format that are always on-hand for immediate machining once the project design is finalised to reduce production time.

EGOIN's focus on product and traceability control is seen as a step prior to defining strategies that allows for processes and material resources to be optimised, thereby reducing production times, energy consumption, and transportation needs. This can be seen reflected in a reduction of associated costs.

Stakeholders

The set of stakeholders involved in this challenge, and which must therefore be taken into account when presenting the solution, are the following:

- **Users** that are looking for comfort within buildings without compromising environmental and economic stability.
- **Architects** that find themselves required to provide increasingly sustainable and quality solutions.
- **Developers** that intend to sell their buildings as sustainable and break into the more elite market of more environmentally-friendly buildings.
- **Builders** that are facing tendering processes with new construction formats (industrialised) that they lack experience with, as well as new product purchasing.
- **Manufacturers** that are looking for more innovative solutions that fit with current trends and allow for their products' future to be guaranteed.

- **Workers** that are seeking to identify their values within the company and are committed to more efficient and less polluting production means that also boost their health and well-being by guaranteeing a better working environment.

- **Shareholders** that, having seen the market trends, are investing in solutions that are tech-based, efficient, cutting-edge, and increasingly sustainable.

- **Project and BIM Managers** that collect all construction process and product information to produce a project's final technical documentation that reflects what is actually constructed (called "**As Built**").

- **Public Administrations** responsible for providing technical conditions for public tenders that are in line with current requirements and standards while anticipating future sustainability and/or environmental impact requirements.

- **Product certifications** that require true data on the real environmental impact of the products it certifies in the form of type I eco-labels (i.e. *FSC, PEFC, Craddle to Craddle, EU Ecolabel*) and type III eco-labels with names like "Environmental Product Declarations (EPDs)" (i.e. *EPD, DAPc, GlobalEPD, IBU*).

- **Companies** that are increasingly aware and involved with the environment and, in turn, more open to contracting "green" solutions and proposals that benefit them economically while committing to the future in terms of sustainability.

- **Investment funds** that choose sustainable development as a future trend and provide new investment products to satisfy the needs of their client portfolio, both in terms of individual profiles (i.e. *green mortgages*), as well as large companies (i.e. *carbon emissions rights*).

Needs

The needs of EGOIN S.A. lays not only with developing **new products**, but also those that result in a common good, taking into account the fundamentals of sustainable development.

We understand sustainable economic development at EGOIN S.A. to be the control and **traceability** of our products in order to increase the quality of our processes. We see recording **resource consumption** (electricity, water, gas, and other fuels and raw materials) as essential to sustainable environmental development, which is why this is done throughout our production chain, raw material transport [9], product, auxiliary means, employees [10], and finally assembly, applying this to each project as a prior step to improvement-related decision making. Finally we have sustainable social development, which includes **data processing** that satisfies the needs of all other stakeholders that will be those responsible for closing the building's cycle.

Of particular note is the need for product and process control that will allow production to be optimised, leading to reduced cost and less time from manufacture through on-site assembly. This will result in more efficient and higher quality service that benefits all parties involved.

Objectives

EGOIN's ultimate vision is to **design a solution that enables information processing** and **helps register process data applied to each project specifically** throughout **all product phases, from extraction and transport** to the factory, to **production, transportation, and assembly**. These records should cover **traceability as well as environmental resource consumption**, in addition to

storing certifications and documentation, with the purpose of providing a **true overview of each product's environmental impact**. This information must be **easily accessible for all stakeholders**.

To do this, a solution is envisioned to allow:

- Locating and controlling our products.
- Storing and recording data, in addition to documentation and certifications.
- Quick and easy access to information.

The ultimate solution should respond to the following questions:

1. What **technologies are most appropriate for tracking** raw materials and products during all of the project's phases?
2. How can I **identify the sources of information** extractable from the different production processes during all of the project's phases (extraction, production, and assembly)?
3. What **support mechanisms** can I establish to ensure **data collection** in cases where **information is difficult to extract**?
4. How can I ensure that different technicians **register data in a way that is systematic and organised**?
5. How can I ensure that all of the different **stakeholders** are taken into account so as not to lose any relevant data?
6. What are the **most ad-hoc innovative technologies** that can meet defined requirements?
7. How can the solution **record, integrate, and store data collected by the product and raw material control and location mechanisms** so that they can be accessible to all stakeholders?

Scope

The scope of the challenge consists of designing a solution that can **control and record traceability, as well as calculate environmental impact during the second processing, storage, and distribution process.**

For testing and validation, this solution will be applied to a **pilot project with real data, recording the data of a small yet complete and significant project in terms of using different products.**

The **pilot project will begin in the second processing stage, with raw materials arriving for the manufacturing processes of the three main products: CLT, GLT, and light frame**. The solution will collect and record the consumption of the different processes used for each one (see illustration 4). **Consumption associated with product storage and transfer between EGOIN's three facilities** will be considered. Finally, consumption associated with **product transport to the assembly site** will also be taken into account

Illustration 4. Scope of the challenge within EGOIN's manufacturing and assembly process

The following table shows the requirements and characteristics of the challenge broken down by phases or variables:

Functional need			*Weighting*[9]
1. The solution **allows for raw materials and products to be traced** throughout the project's phases.	1.1.	The solution must be capable of providing precise and reliable information on the location and status of products and raw materials.	5
	1.1.	The solution must be able to provide information in real time in order to facilitate quick decision making.	2
	1.2.	The solution must be adaptable to different types of products and raw materials, and must be capable of supporting changes to logistics and work flows.	6
	1.3.	The solution must be capable of being integrated with other systems and existing technologies, such as inventory management systems or warehouse automation systems.	7
	1.4.	The solution must provide complete oversight of the products and raw materials, from their origin to their final destination.	Requirement
	1.5.	The solution must be safe and protect confidential information and data on products and raw materials.	8
	1.6.	The solution must be capable of handling large volumes of products and raw materials, and be scalable alongside the growth of the business.	8
	1.7.	The solution must be easy to use for the personnel involved in logistics and work flow.	6
	1.8.	The solution must help reduce human error in inventory management and logistics.	7
	1.9.	The solution must quantify consumption associated with the processing and transport of raw materials, products, and individuals, automatically determining the total environmental impact of a project (carbon footprint).	Requirement
	1.10.	The solution must be capable of collecting and transferring data to the data storage and recording system.	Requirement
	1.11.	The solution must be economical and logistically viable, considering the potential benefits versus its implementation and operation.	9
2. The solution **takes into account all of the entities and stakeholders** of the operation.	2.1.	The solution considers the entire value chain and production process of the industrialised CLT and GLT wood construction systems.	8
	2.2.	The solution includes the various production processes to study the problem of obtaining data in each case.	Requirement
	2.3.	The solution allows for extractable information sources to be identified in each process (whether that is through the machines themselves, manufacturing files, or other means).	9
	2.4.	The solution allows for the different study formant and auxiliary on-site assembly measures to be included in the system to be analysed.	7
3. The solution has the ability to **use and manage** volumes of data.	3.1.	The solution has the ability to centralise and store all of the data collected during all of the project's phases.	Requirement
	3.2.	The solution is able to capture and record precise and complete information.	6
	3.3.	The solution is reliable and consistent in capturing and recording information.	7
	3.4.	The solution is safe and protects confidential information and user data.	Requirement
	3.5.	The solution is able to manage large volumes of information and be scalable alongside the growth of the business.	8
	3.6.	The solution is accessible to all authorised users, allowing for information to be recovered when necessary.	9
	3.7.	The solution ensures the integrity of data stored, which means that data must be complete and precise, and should not have been altered or corrupted.	6
	3.8.	The solution is easy to use and navigate for users.	6
	3.9.	The solution is able to process and recover information quickly.	6

[9] Weighting based on a scale of 1 to 9, and compulsory requirements.

	3.10.	The solution is versatile and capable of handling different kinds of data and file formats.	6

Table 1. Requirements and characteristics of the challenge

Next steps

The execution of different points and, therefore, overcoming the challenge, will mean the total integration of data into our system for exhaustive and real control of the year's building assembly and in-factory production volumes. In 2022, EGOIN S.A. closed with approximately 14,500 m3 of CLT and 4,800m3 of GLT, and 173 buildings constructed. In line with the Company's Strategic Plan for 2025, CLT production capacity is estimated to reach 35,000 m3, and GLT of up to 15,000 m3.

The steps following achievement of the challenge will be focused on processing and publishing the information obtained, associated both with environmental impact and product traceability. For this reason, it will be necessary to design a solution that allows for all stakeholders to easily access the data, documentation, and certification registration and storage system. Data visualisation must be clear and useful.

Said solution must be able to show the product's carbon footprint throughout its entire life cycle, and include the quantity and type of energy used for its production, including the energy used for raw material extraction, manufacturing, transportation, and assembly.

In turn, said solution will provide product origin identification, including the location of suppliers and details on its production, leading to the publication of information on complete product traceability throughout its life cycle.

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