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Green Public Procurement and the circularity of the built environment

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Abstract.

The case study presented in this paper is a demonstration of the success of a green public procurement (GPP) model that allows to build buildings in accordance with the principles of the circularity by ensuring sustainable consumption and production.

The relevance of green procurement has lately become a focus of research because of public institutions' growing interest in circularity for built environment investment. The case study of a school gym presented in this paper is emphasising the role the public authorities are playing in promoting the transition to the circularity of the built environment through sustainable procurement. Despite being a voluntary instrument, GPP also plays a significant part in the global efforts to develop a more resource-efficient economy. It can help to develop a critical mass of demand for more sustainable buildings that would be difficult to bring to the market otherwise.

The challenge of convincing public-sector institutions to use GPP across nations, to become 'normal practice' continues and will drive the market for environmentally friendly buildings. The case study presented demonstrate that the GPP model is widely replicable and leads to positive outcomes. It has already been applied for the Brancati secondary and high school project built in Pesaro, Italy, that has been awarded by the International Jury of the Green Solutions Awards 2020-21, Construction21, the Prize for the Energy for the Temperate Climate International Platform category.

1. Introduction

Climate change is having a big influence on businesses, society, and people. It is becoming increasingly clear that a transition to a low-carbon economy is required. The building and construction industry is critical to this transformation because it accounts for over 40% of worldwide greenhouse gas (GHG) emissions (OECD, 2015). The materials utilized, as well as the heating, cooling, and lighting of buildings and infrastructure, are key contributors to these emissions. Besides, according to the Organization for Economic Cooperation and Development [1] [2], the construction industry accounts for 25–40% of overall energy use in OECD nations [3]. The sector is mainly responsible for environmental consumption and sustainability issues due to its extensive use of resources and energy. Buildings contribute to greenhouse gas emissions both before and after they are functioning.



The construction industry would be expected to actively manage climate change concerns and to accept responsibility for its direct or caused carbon emissions. It will also need to prepare for a changing environment and increase resilience to the harmful effects of climate change.

Public authorities are significant consumers in Europe, spending around 1.8 trillion euro each year, accounting for approximately 14 percent of the EU's GDP. They may contribute significantly to sustainable consumption and production by utilizing their purchasing power to select goods and services with reduced environmental implications [4]. Contracting authorities must include steps in their procurement procedures and use GPP to face the climate impact of their new buildings over their complete lifecycle.

GPP is also concerned with market impact. By fostering and implementing GPP, public authorities may provide significant assistance for the growth of green technologies and enterprises. Governments can regulate a considerable percentage of the market in various sectors, especially construction, and their actions have a significant impact [5]. Thus, public procurement may be used to address the environment impacts in buildings throughout their life cycle [6].

This paper examines some of today's most pressing green public procurement issues to inspire knowledge and unlock the full potential of public authorities by achieving a truly circular transition in the building sector through practical procurement application.

1.1. The role of public authorities towards the circular transition

GPP is defined as "a process by which public authorities seek to procure goods, services, and works with a reduced environmental impact throughout their life-cycle when compared to goods, services, and works with the same primary function that would otherwise be procured" in the European Commission's Communication Public procurement for a better environment [7].

Sustainable public procurement is a 'greening' procurement process that acknowledges the role the public authorities may play in the transition to a circular economy.

GPP aims to close energy and material loops within supply chains while reducing and, ideally, preventing negative environmental impacts and waste creation during their full life cycle. Procuring in an environmentally responsible manner entails thinking beyond short-term demands and considering the long-term implications of not only purchases but also works, [8] which necessitates fundamentally changing one's mindset when approaching sustainable related concerns in the industrial sector. More specifically, beginning in 2030, the Life Cycle Global Warming Potential (GWP) of new buildings must be calculated, notifying on the total life cycle emissions of new construction [9].

The role of public procurement in the transition to a circular economy is crucial. Adoption of GPP in public construction contracts can promote the uptake of environmentally performing buildings. The definition and criteria for identifying and promoting "greener" building construction and renovation are based on a life cycle approach and encompass aspects that influence the whole supply chain, such as the use of raw materials and manufacturing methods, as well as the eco-design planning for disassembly.

Member States and Community Organisations are urged to increase the connection between green public and commercial procurement. All these aspects may also be used to guide private procurement procedures [10]. It appears evident that the climate change issues and natural biodiversity loss that we currently encounter as a population are so immense and severe that we cannot simply ignore viable solutions.

Nonetheless, addressing climate change and ensuring a sustainable, thriving, and healthy environment are critical to collective well-being and central to the GPP approach's ambitions and responsibilities to reduce greenhouse gas emissions while simultaneously growing the economy, increasing employment, and productivity [11].

2. A novel business model for public buildings using the GPP process: The case study of a new gym

Sustainable Procurement is defined as a public tendering process promoted by local authorities used to acquire goods and services ("products") and develop public works and housing in a way that combines

sustainability concerns into design planning, paying special attention to the building's whole life cycle, construction site management, and product and technology choices to reduce negative effects on society and the environment and offers priority to suppliers and construction companies who can produce beneficial results for the environment, their employees, and society [12].

Sustainable procurement is an effective way for the public sector to help achieve the 17 UN Sustainable Development Goals (SDGs) [13]. (United Nations, 2015) This case study is a good example that shows the clear links between procurement and the UN goals and how sustainable public procurement will help achieve them [14].

In Italy, the Minimum Environmental Criteria (MEC) for all public construction contracts D.M. 24/12/2015 and updated with D.M. 11/10/2017 [15] both in new construction and renovation of existing buildings, in accordance with the new Procurement Code D.lgs. 50/2016, [16] were made mandatory to promote sustainability in the building sector, since 2015.

These Criteria, which are based on the principles of the circular economy, include several critical measures listed below:

- all significant building materials and products must have a minimum and approved recycled content.
- according to the European Waste Directive, full compliance with the 70% recovery level for construction and demolition waste is required.
- obligation to utilize selected demolition methods and design for disassembly/deconstruction for 50% of the materials used.

Though the implementation rate of Minimum Environmental Criteria for Public Buildings is still particularly low, in 2020, the percentage of public tenders that use these criteria was approximately 18%, [17] this level is extremely significant for the adoption of the circular economy and expand the market's supply of compliant building products [18].

Pesaro Municipality has been working on sustainable public procurement (SPP) since 2009 by experimenting innovative projects to make “greener” the tender or procurement procedure. These include, among other things, the application of environmental certification scheme, circular economy ideas, and ways to supporting sustainable innovation. From 2017, SPP has become a part of Pesaro's overall strategy on procurement urging procurers to evaluate opportunities for sustainability in every contract. The Municipality is aiming to improve current tendering process model and establish new procurement criteria that consider product and service life-cycle impacts, circular economy, and climate concerns including the construction activities. In this case, the tender uses core sustainability indicators to obtain a sustainable building and measures carbon, materials, water, health, comfort, and climate change impacts throughout the building's life cycle [19], [20].

Thus, the tendering process incorporates sustainability principles at the core of its delivery and reflects sustainable procurement practices in construction throughout the following four phases:

- the analysis of the needs and constraints,
- the design planning is based on the users at large needs,
- the rules of the invitation to tender are based on the required sustainable standards,
- the continuous monitoring of the construction site.

With a total budget of € 3.5 million, the following overarching themes related to the four areas identified are the basis for including sustainability principles in the tender regulation for the new school gym:

- Economic area: cost efficiency,
- Environmental area: low carbon footprint,
- Social area: comfort for all,
- Technical area: design for efficiency, recovery, and reuse.

These concepts have been transformed into project-specific aspects, which are further enhanced by performance requirements included in the tender. Prior to the design process is the examination of the demands of the users that are combined with these sustainability principles.

Before the start of the project, also a sustainable procurement strategy was performed to identify the goals, key performance indicators to improve building sustainability and results, and most importantly, the budget, where the cost of a project is an essential issue for the municipality as the client/owner.

The goals to be achieved are developed based on the study of the demands and needs of all the stakeholders engaged in the building's implementation process. Then the goals identified are transformed into technical requirements and clearly describe in the tender to make them mandatory. After contracting it is also important the construction site phase to control the flow materials and the construction waste to achieve a low environmental impact. Finally, the monitoring phase in use to ensure to be obtained the expected results.



Figure 1. Sustainable Public Procurement Strategy Scheme

As it is presented in Fig. 1 it is possible to define the strategy scheme for the SPP application on public building construction to achieve a truly sustainable building. What is more important is that this strategy establishes a holistic and systematic approach easily replicable by all public authorities in Italy and Europe.

To ensure the building's safe usage and long operational life, constant monitoring of safety indicators must be implemented at the design stage, the start of construction activities, and during the building's commissioning. Monitoring during construction enables for the early detection of structural flaws and foundation sinking, as well as the analysis of physical and chemical qualities of the ground.

Minimum energy performance requirements for public buildings are established at the national level using a defined EU framework. All new buildings owned by public institutions must be "virtually zero-energy structures" by January 1, 2019, according to the Directive 2010/31/EU on the energy performance of buildings [21]. Furthermore, the Energy Efficiency Directive establishes mandatory requirements for public building restoration and construction to satisfy minimum energy-efficiency standards [22].

In this context, the European Union's directive has been accepted by the Italian government with the Decree of the Ministry of Economic Development of 26 June 2015 [23], since 2019 public buildings must reach the near Zero Energy Building (nZEB) standard. The energy standard of the gym project presented in Fig. 2 achieves the nZEB by means of technical passive design and PV panel plant for the needed renewable energy production. The architectural design maximizes the building envelope efficiency compared to a standard design thanks to the green roof and the ventilated wall made of porcelain stoneware to reduce not merely the energy demand but also the maintenance cost of the façade.

Based on sustainability principles, this SPP process entails the following important features for the school-gym to enhance its sustainability in four distinct domains at the same time: economic, environmental, societal, and technical domains.

Therefore, the implementation process on which this SPP is based evolves along these four domains with specific targets and measurable outcomes:

- economic benefits in energy savings and reduction costs for maintenance.
- environmental benefits such as water usage and waste reduction.
- societal advantages such as inclusive and comfortable buildings for all.
- technical benefits such as eco-design and innovation improvement.



Figure 2. The new school gym, Source: F. Serafini

The objective is to translate the sustainability goals SDGs into technological features to minimise the environmental effect of the building from construction through usage [24]. The 11 technical requirements as criteria for obtaining the best tender offer are presented in Table 1.

Table 1. Tender technical specifications

Building Structure	Replace the concrete structure with timber structure
Building Envelope	Solar screen
Acoustic Performance	Acoustic improvement based on UNI 11367, UNI 11532-2 e CONI N.1379 Electro-acoustic plant
Energy Performance	Use of Controlled Mechanical Ventilation and Heat Recovery Systems & Heat Pump Energy consumption monitoring system
Environmental Performance	Waste materials management Water consumption reduction Rainwater harvesting Material optimization Environmental energy efficiency certification

The achievement of these technical criteria described in the 11 tabs as listed in Table 1, is prioritised, whilst the economic offer is assigned a comparatively low value. This is needed to stimulate construction companies to improve the building's environmental and social performances on the bases of the criteria identified.

The SPP differs from the traditional practice because the bidders are asked to provide their best technical offer rather than the lowest price. Moreover, the call for tender defines specific technical standards to make the building achieve the greatest quality, based on sustainable criteria that fit the

demands of the final users to maximise social, environmental, and economic benefits for the public authority, the supply chain and society as a whole. In addition, bidders must submit a LEED certification plan at the GOLD standard to verify the building's accomplishment of the environmental criteria including throughout the usage stage.

The life cycle thinking approach provides economic benefits by avoiding unnecessary expenditures and retaining long-term value for money, ensuring energy savings, and lowering operating expenses. As a result of rising demand, product and technology costs are falling, allowing the local market to expand.

It is worth mentioning that, because the life cycle thinking approach is completely absent in the typical procurement process, all these elements are rarely analysed comprehensively with a systematic approach.

In this case, the main expected outcomes of the competition are the near-zero energy building standard and LEED GOLD certification with a score of 72 points to guarantee energy performance and verify environmental impacts.

The superiority of the SPP compared with traditional procurement is demonstrated by measurable evidence achieved in the school gym building in term of:

- CO2 emissions reduction compared with a traditional building

It is expected to produce about 10 kg of CO2 emissions compared with a standard building

- Choices of materials and construction method

Verify the quantity of certified EPD materials used

- Energy consumption reduction thanks to the improvement of passive design

Calculation of the percentage of consumption reduction and energy saving costs

- Waste reduction by primarily preventing its generation and reducing it as much as possible.

Percentage of recycling materials obtained

- Higher indoor comfort quality

Monitoring campaign for acoustic comfort and thermos-hygrometric parameters

- Satisfaction of the users

Interviews

- Improvement of green skills in the whole value chain

Number of workers trained, and number of training lessons organized

Such outcomes are feasible because bidders are driven to take a different approach to the project to participate in the call for tender and win the contract. To develop their optimum offer, businesses must shift their mindset and embrace a life cycle approach to the building project as a whole.

It is worthy to mention that the Italian national standards organization UNI has already included this SPP model in UNI/TR 11821 as one of “good circular economy practices for evaluating their functionality and services and promoting replication”.

3. Discussion

Sustainable public procurement will be critical in realizing the objective and setting the path for ecologically responsible, competitive, and socially beneficial solutions. It will also be an effective powerful tool in the hands of the public sector, which is more focused on attaining global environmental goals. It is recognized that public expenditure can be a significant driver for change. Empowering public procurement may create a competitive market force in the construction industry.

This SPP is more transparent and resilient and can strengthen supply chains, empower construction firms and be a catalyst for realizing sustainable and inclusive development. It also offers opportunities to accelerate the transition to low-carbon economies, to recover from the Covid pandemic's socio-economic effects, combat corruption, and decrease inequality.

The value of providing pleasant and healthful building environments is becoming more widely recognized. This is supported by growing scientific evidence relating healthy buildings to increased productivity and enjoyment. A healthy and appealing building environment with enough daylighting, ventilation, consistent seasonal temperatures, user control, and vistas of natural spaces can lead to higher satisfaction, fewer illness-related absences, and greater efficiency.

The construction of the gym school process demonstrates how to integrate sustainability requirements in public procurement and how to ensure their achievements. This SPP plays a strategic role at stimulating development and diffusion of environmentally sound, at promoting the integration of social development, environmental protection, and economic feasibility in the building sector.

The novel business model for the school gym buildings using the GPP process and SPP has established its own measurable thresholds to be achieved. Some of them can be compared with the ones found in the literature review presented in the paper. The others are case study specific and unique to the gym case study that were developed to meet the client's needs and demands. Nevertheless, from the sources the authors of the paper have studied, the overall results of the gym building are superior to the ones found in the literature mentioned in the references.

This is proven by the tangible and measurable benefits with specific defined thresholds for the gym building due to the implementation of a sustainable SPP process are as follows:

- environmental protection, such as much lower CO₂ emissions than a traditional process, effective water management, waste management to improve recycled materials, energy efficiency, and resource usage including certified environmental material (EPD) to ensure the low environmental impact.

- from societal point of view improving quality of life and wealth distribution, creating better working conditions, establishing higher quality standards for products, resulting in increased performance, raising environmental consciousness by recognizing environmental problems that affect the entire society. The social benefits were also underpinned by the number and size of stakeholders involved during the project i.e., the user, the construction companies, and the technical staff.

- concerning economic aspects saving money from energy efficiency, water consumption reduction, optimisation in the resources use, fostering innovative green technologies and products, creating a green marketplace and new green jobs. In addition, projects like the gym foster green jobs and can result in the development of new materials or new businesses that are required by SPP exigencies.

4. Conclusions

The SPP model identifies a systemic process which addresses the construction of new public buildings to ensure sustainable goals and obtain the related benefits for the whole community. It creates real impact focusing on capital expenditure, establishes a sector pathway considering the actual regulations constrains, while adopting sustainable building practice.

The school-gym offers an excellent energy efficiency and minimizes energy consumption thanks to the use of certified materials and the efficiency of the envelop studied in relation to the surrounding microclimate.

The smart use of materials contributes greatly to reducing embodied energy. The required and monitored use of renewable materials such as wood for the structure help to heavily reduce the embodied energy. However, this building capitalises not only on the use of low embodied energy materials, but also the use of sustainable and renewable energy sources to power lights and other appliances thanks to PV panels on the roof, resulting in lower energy expenses. The green roof protects biodiversity, minimizes the island impact, and reduces the water-bomb effect ensuring environmental benefits. Reducing the maintenance is a priority in its design and construction, consequently the maintenance costs are lower. Operating cost savings, shorter payback periods and increased asset value in the new gym building are expected.

The gym does not only offer energy efficiency but also health efficiency and wellness. People who will use it will enjoy better indoor air quality in addition to several other health and wellness benefits. Because sustainable building materials are free of cancer-causing substances and harmful toxins, the school-gym reduces harmful effects on the communities and environments in which it is located. With its bright natural lighting, this space provides pleasant well-lit illumination that enhances wellness. Additionally, the availability of natural lighting decreases the need for supplemental lighting from light fixtures, in turn decreasing the amount of electricity used in the building.

Finally, the implementation of such a model improves worker and technician skills since it requires regular updating of design and material requirement knowledge. Furthermore, this model drives the

market toward sustainable materials since they are required in the project and in the call for tender, and it pushes construction businesses toward novel technologies to meet the high standards of the projects to produce a truly sustainable building.

5. Recommendations

It is critical to have a debate about the benefits of increasing sustainability criteria within SPP in construction. Municipalities can enable construction companies and supply services to use SPP and optimise value for money by leading the approach on sustainable procurement in a systemic way.

It is crucial to strengthen national capabilities through a governance strategy that involves the use of a voluntary environmental certification scheme and the application of appropriate SPP process to avoid redundant certification.

There is a need to incorporate sustainability criteria into the market system and create a database to provide a rapid overview of the products covered by the standards and labelling certifications that may prevent the adoption of the sustainable public procurement.

Consensus and dispersion of recognition of the SPP is needed to avoid the unnecessary increase of the number of sustainability criteria and keep the most important ones, only. It is also critical in sharing this SPP process for it to be widely adopted.

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