sustainability

MDPI

Article

Implementation and Sustainability Assessment of a Public Procurement Strategy

Houda Taoudi Benchekroun [1,*], Zoubida Benmamoun [2] and Hanaa Hachimi [1]

[1] Systems Engineering Laboratory, Sultan Moulay Slimane University, Beni Mellal 23000, Morocco
[2] Faculty of Engineering, Liwa College of Technology, Abu Dhabi 41009, United Arab Emirates
* Correspondence: houda.benchekroun.t@gmail.com; Tel.: +212-661-317-923

Abstract: The COVID-19 pandemic crisis marks a rare example of a supply disruption that had a devastating effect on the global economy. The vaccine has then been considered to be an effective long-term solution. The particularity of the supply chain of the COVID-19 vaccine is that the procurement is made by government agencies directly from the manufacturers, thus bypassing the typical vaccine supply chain of distributors and wholesalers. The first purpose of this paper is to further understand the public procurement strategies (PPSs) for the COVID-19 vaccine in a pandemic situation, using a methodology that brings together Kraljic's purchasing portfolio model, Porter's five forces analysis and a multi-attribute decision making method. The second aim is to evaluate the sustainability of a PPS, using the sustainable development analytical grid (SDAG), an analytical tool that addresses six dimensions: ecological, social, economic, ethical, cultural and governance. To assess the effectiveness of the methodology, we consider Morocco, an emergent country, as a case study. It results that Morocco's approach is in line with the theoretical strategy: diversification and bringing the production in house. The sustainability assessment shows that the PPS covers the six dimensions, but considering the urge for an economic and social recovery, some sustainable development objectives are to be prioritized.

Keywords: public procurement strategy; sustainability assessment; sustainable development analytical grid; Kraljic's purchasing portfolio model; COVID-19 vaccine procurement; supply disruption

check for updates

Citation: Benchekroun, H.T.; Benmamoun, Z.; Hachimi, H. Implementation and Sustainability Assessment of a Public Procurement Strategy. *Sustainability* **2022**, *14*, 15565. https://doi.org/10.3390/su142315565

Academic Editor: Yichuan Zhao

Received: 29 September 2022
Accepted: 16 November 2022
Published: 23 November 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Governments or public sector organizations use their consistent budgets to buy large quantities of goods, services and public works [1,2], for the local economic development or economic stabilization [3]. According to the World Bank, in 2018, public procurement (PP) accounted for 12% of the global GDP or around USD 11 trillion. Thus, the public sector does not only perform the role of regulator, it is also often considered to be the most important customer within a country [4].

This purchasing power is used by governments as a strategic tool to achieve environmental, social and economic objectives, in line with national priorities [5], to influence the practices of private sector organizations [6] and to promote innovation by creating an economy of scale giving an incentive to technological investment and a guaranteed profit margin [1].

1.1. COVID-19 Pandemic

The severity of infectious diseases, such as SARS-CoV-2 even in the most technologically developed countries [7], forced governments all over the world into adopting, almost simultaneously, significant measures, including a general lockdown, border shutdown, closure of production units, and restrictions on air transport networks that lead to a low supply of raw materials [8]. The crisis triggered by the COVID-19 pandemic has brought

extra responsibilities on PP with regards to: first, guarantee the continuity of public services, as well as citizens' wellbeing, and then to answer growing demands for resilience, innovation and sustainability [9].

The efficacious and safe vaccine, distributed equitably and rapidly, has been acknowledged as a global public health priority [10]. It has been considered to be an effective long-term solution to the COVID-19 pandemic, since it is supposed to minimize morbidity and mortality, once a high proportion of the population is immunized [11], and also to have clinical and socioeconomic benefits [12].

This requires a vaccination agenda which seeks, as a first step, the protection of the most vulnerable people, as well as the prevention of illness and absenteeism amongst health care workers, ensuring the proper functioning of health services, before widening it to the rest of the eligible population. Achieving worldwide mass vaccination campaigns under particularly constraining circumstances is then a big challenge for the vaccine supply chain, and notably for the procurement function of each country [13].

The complex nature of the pandemic vaccine supply chain has been substantially covered by research since the onset of the pandemic. Alam et al. (2021) showed that the main constraints the world is currently facing, are manifested in meeting the needs of individual countries, especially given the vastity of the global volume required, as opposed to the current production limitations and the complexity of the context, in terms of logistics and health facilities [14]. In the same sense, Phelan et al. (2021) highlighted that the vaccine nationalism is another major barrier to equitable vaccine access [15]. Nevertheless, little effort has been exerted in the area of procurement which is a key link in the COVID-19 vaccine supply chain. As a matter of fact, Gianfredi et al. (2021) presented a review, based on the limited available literature, and concluded that the optimizing costs and avoiding vaccine unavailability, while enhancing equity and global accessibility, is possible through a sustainable vaccine procurement system [10].

1.2. Public Procurement Strategy

To optimize a procurement process, it is important to select the appropriate procurement strategy [16], which is all about the choices made in determining what is to be delivered through a particular contract, the procurement and contracting arrangements and how secondary procurement objectives are to be promoted [17]. Then, the purpose is to meet the internal needs while taking full advantage of the buying power, decreasing the supply vulnerability [18], and being reflective of the organization's goals, including sustainable development goals (SDGs) [4].

The study of Lin et Al (2021) focused, among other things, on the procurement strategy of the influenza vaccine in an uncertain framework, related to supply and demand during the coronavirus pandemic [19]. However, the supply chain of the COVID-19 vaccine presents a different status quo, compared to the standard vaccine supply chain, in the sense that the purchase for the first one is made by government agencies directly from manufacturers, thus bypassing the typical vaccine supply chain of distributors and wholesalers [13].

An appropriate public procurement strategy (PPS) is essential for the vaccine distribution and would diminish the adverse impact on SDGs, through reducing the negative environmental impact related to hospitalization from COVID-19 and shifting towards a "prevention-oriented, resource-saving and sustainable world" [20]. Furthermore, the fair distribution to low- and middle-income countries, would contribute in achieving many of the SDGs, in particular: economic growth, good health and wellbeing, reduced inequalities, peace, justice, strong institutions, and lowering poverty. In that sense, Alam et al. (2021) identified 15 challenges to the vaccine supply chain and their implications on the SDGs [14].

1.3. COVID-19 Vaccine Contracts

Contracts for the procurement of doses of the COVID-19 vaccines, are negotiated by countries singly or in a group [10], under confidential purchasing agreements. In this

context, the European Union pre-ordered a large volume of vaccines to benefit from the economies of scale. To secure the supply of vaccines, the European Commission negotiated, on behalf of the member states, with pharmaceutical companies engaged in developing the coronavirus vaccine. The doses were then to be divided between the member states, based on their population. An advisory committee was created to review the procurement files, on the basis of various criteria. It consisted of experts in vaccinology, immunology, clinical practice, research and development, and regulation aspects. The members were obliged to maintain the secrecy and have no conflict of interest.

The assessment was based on the analysis of benefits and risks of the vaccine, according to the current and most up to date scientific knowledge, production and supply elements, contractual and legal aspects, and the cost price.

When a file is submitted by the European Union, for a potential purchase of a COVID-19 vaccine, there are two possibilities: 1st—to file with a purchasing obligation and the members states have a deadline to notify whether they wish to opt-out, 2nd—to file with a purchase option that is, that the purchase is not mandatory, and it can be decided upon at a later stage. The first file was submitted by AstraZeneca on August 17, 2020. On the basis of the available scientific data, no critical point making an opt out necessary, was found.

Granting marketing authorization of a vaccine is independent from the process of the procurement consultation. If the marketing authorization process is not successful, the contract is terminated.

In this context of the global race for the COVID-19 vaccine, the coordination of the vaccine strategy in Europe was designed by the European Commission to limit the effects of competition between the member states.

Another example is the Government of Canada, that invested over CAD 1 billion to secure access to the promising vaccine candidates. This included up-front payments that the companies required, to support the vaccine development, testing, and the at-risk manufacturing. Subsequent payments were contingent on the vaccines passing the clinical trials and obtaining the regulatory approval.

Thus, even before any vaccine candidates were approved, many high-income countries ensured their supply of vaccines by purchasing enough doses to vaccinate their inhabitants, numerous times over.

Then, the vaccine makers, among the wealthy nations, took the lead in getting large advance market commitments (AMCs), investing public budgets in the vaccines' research and development, and exploiting their buying power to conclude contracts with vaccine candidates, in order to get the vaccine first.

It should be noted that encouraging private investment into vaccine research and development, and production capacity is usual through AMCs. That is a legally binding contract between a sponsor and a vaccine developer to commit to purchasing a pre-agreed value or amount of a currently unavailable vaccine [21]. Then, an AMC diminishes the risks for the producers and guarantees the widespread availability of the vaccine, once licensed [22].

To obtain a share of the vaccine, countries with a manufactured capacity and a restricted buying power, such as Brazil and India, used another approach. They negotiated with the vaccine candidates, fabrication clauses under advance market commitments.

Other nations, with the capacity to organize clinical trials, tried to benefit from this, to negotiate procurement contracts.

However, several low-income countries, including some African countries, would count entirely on donations, and development loans or grants.

To deal with the gaps with high and low-income countries, COVAX and other alliances invested in the development, production, and acquisition of a broad range of vaccines, to guarantee the fair distribution to low and middle-income countries. The member states buy in at their desired coverage rate, and the vaccines are allocated by the population level.

Conversely, many manufacturing nations are using export restrictions to satisfy their own needs firstly, causing the delay of the delivery for low-income countries.

1.4. Sustainability Assessment (SA)

Due to the emergence of the new variants of the coronavirus, the risk of inefficiency of the COVID-19 vaccine, the extension of the vaccination to the youth, and the strategy of booster shots for an effective protection of citizens, immunization campaigns are likely to be of a longer duration, that is why a sustainable vaccination management is needed [23]. The research of Klemeš et al. (2021), assessed the energy and environmental footprints, due to the mass vaccination, and showed that they were significant in the vaccination lifecycle in the level of manufacturing, transportation, and storage (cold supply chain accounts for about 69.8% of the energy consumption of the vaccination process), disinfection and waste management [24]. Moreover, Hasija et al. (2022) have warned about the disruptions that vaccine waste (discarded vials, dry ice for vaccine storage, syringes, needles, personal protective equipment, vaccine packaging materials, based on non-biodegradable plastic, etc.) would generate in the environment and their impact on human health, if no sustainable measures to address the waste management are taken [25]. Yet, because of the severity of the current situation, the vaccine deployment is seen by decision makers as being of a higher priority than the sustainability matters [23].

SD involves a set of standards and guiding principles [26], among the most common of these are the triple bottom line [27]: environmental integrity, social equity, and economic prosperity [28]. The 2030 SD Agenda defined the 17 "interrelated" SDGs that cannot be reached without sustainable economic progress [29]. According to Devuyst et al. (2001), when trying to make society more sustainable, a sustainability assessment (SA) is needed to gather and report information, to undertake new policies and to make decisions [30,31]. The purpose is to make sure that "plans and activities make an optimal contribution to sustainable development" [32].

However, SAs are complex since they imply varied dimensions [33]. Scientific research is making efforts to develop tools and processes that support SAs [34]. In this regard, Villeneuve et al. (2017) stated that the assessment should be periodically adjusted to take account of the new data [33]. Gasparatos (2010) highlighted the fact that analysts are often choosing inappropriate tools for SAs and that the right one shall conform to the values of all stakeholders [35].

1.5. Case Study of Morocco

The COVID-19 pandemic lockdown measures were necessary to limit the spread of the virus. However, they had negative impacts on the economy. a weak export performance, gloomy employment statistics, and a low household consumption, has been a key trend for Morocco in the latter half of 2020, in comparison with 2019.

To break the chain of transmission, to minimize morbidity and mortality, and increase the clinical and socioeconomic benefits, Morocco made the vaccine completely free of charge.

The vaccination campaigns have mainly targeted populations over 12 years of age, according to a vaccination scheme for a total target population of approximately 28,842,000 people, representing about 79.42% (≈80%) of the total population, in order to achieve herd immunity. The priority has been given to several targets, in particular to frontline workers, namely health professionals, public authorities, security forces and national education staff, to elderly persons and to those most susceptible to this virus, before widening it to the rest of the population.

However, establishing a vaccination agenda requires that vaccines are made available in a timely and effective way. Consequently, the proposed case study sheds light on what PPS has to be adopted, theoretically, by Morocco. Subsequently, it will be interesting to know how aligned that strategy is with the approach taken by Morocco, in practice.

Moreover, it is important to note that SD is one of Morocco's priorities, notably within the framework of buying the COVID-19 vaccine, for a variety of reasons, such as: (1) to comply with the 2011 constitution that provides strong added value in terms of good governance in the public sector, including SD and environmental protection goals, (2) to comply with the 2013 decree of public procurement that integrates, amongst others,

sustainability and environmental protection concerns, (3) to recover the pre-pandemic GDP and employment levels, (4) to attract new investors, etc. This stresses the importance of knowing how does this PPS meet the SDGs.

This article aims first, to make a real academic contribution. It is intended to enrich the literature about the elaboration of a public procurement strategy (PPS) and especially in a pandemic context of important global demand and weak supply. A further objective is to address the gap in the existing literature related to the PPS of the COVID-19 vaccine, in general, and particularly in Morocco, and also concerning the gap regarding the sustainability assessment of a PPS. The second aim, is to define how a COVID-19 vaccine PPS should be implemented in a pandemic situation, using mainly Kraljic's purchasing portfolio model (KPM). The third aim, is to assess the sustainability of that PPS. For this purpose, we use the sustainable development analytical grid [33]. The case of Morocco, an emerging country [36], will be considered as an illustration.

The paper sheds light on the following research questions:

RQ1: What strategy has to be adopted for the purchase of a COVID-19 vaccine using the KPM?

RQ2: How does the PPS meet the SD objectives?

RQ3: What PPS has to be adopted by Morocco, as a case study? Is that theoretical strategy aligned with the approach taken by Morocco, in practice?

RQ4: How does the strategy adopted by Morocco meet sustainability?

The remainder of the paper is structured as follows. The following section presents the methodology adopted. Subsequently, we focus on the case study of Morocco, to evaluate the effectiveness of the methodology proposed for setting a PPS and managing the relationships with the vaccine suppliers, then we assess that strategy, in terms of sustainability, to close with concluding remarks.

2. Materials and Methods

2.1. The Kraljic's Portfolio Model

A portfolio model is a tool that combines two or more dimensions into a set of heterogeneous categories, for which different recommendations are provided [37].

The Kraljic portfolio model is an analytical tool developed by Peter Kraljic, in the eighties, to help large industrial enterprises in their purchasing strategies. The aim is to cope with the supply challenges in the context of a scarcity of raw materials, and economic, technological, and environmental changes. Kraljic's method would be the most important single diagnostic and perspective tool available to purchasing organizations [38].

The Kraljic portfolio model uses a 2×2 matrix where the supply items are mapped against two key dimensions: risk and profitability. The Kraljic portfolio matrix (KPM) results in a ranking method of the company's purchasing portfolio to optimize the supply strategies, by giving «pragmatic advice on how top management can recognize the extent of its own supply weakness and treat it with a comprehensive strategy to manage supply» [39], in times of uncertainty.

The KPM is comprised of four portfolio quadrants: bottleneck, non-critical, leverage, and strategic commodities. Typically, one strategy is recommended for each quadrant, as depicted in Figure 1. From this matrix, professional buyers can choose the appropriate strategy for each category, regarding the supplier relations, by exploiting the company's full buying and bargaining power [39].

The overall vision given by the KPM helps identify the strategy to be applied, in order to maintain a purchasing position into one of the four quadrants, as well as the strategy needed to move to another matrix cell [40]. The purchasing portfolio analysis is also intended to evaluate the organization's position in the supply market [41], as shown in Figure 2.

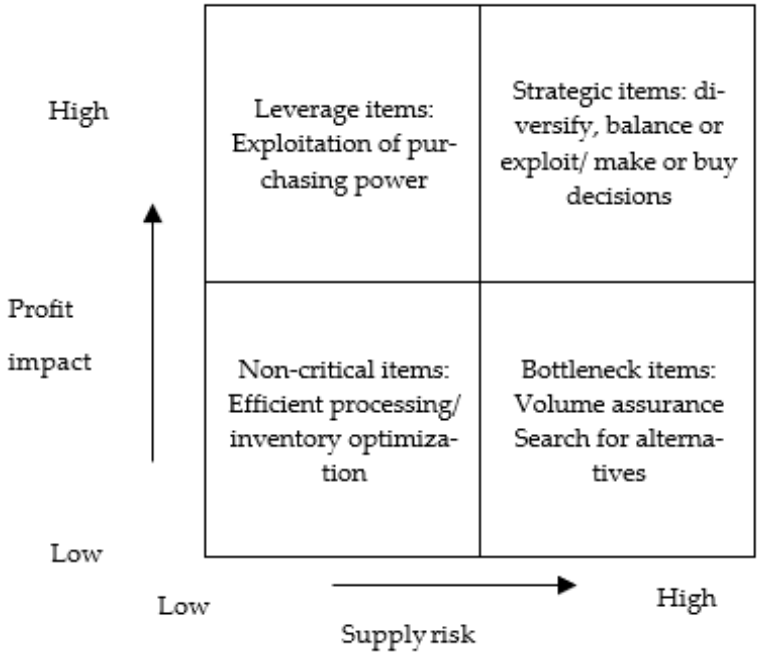

Figure 1. The Kraljic's matrix: categories and recommendations. Source: Modified from Krajlic (1983) [39].

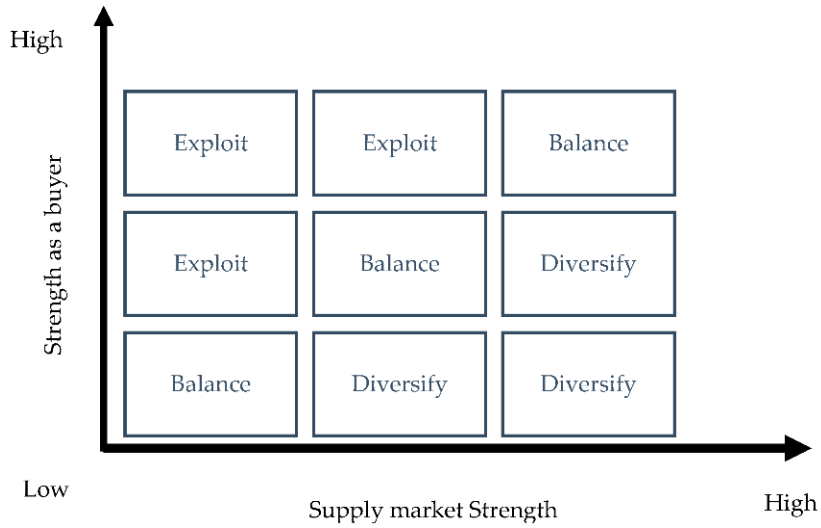

Figure 2. The purchasing portfolio matrix. Source: Modified from Krajlic (1983) [39].

2.2. Sustainable Development Analytical Grid

To assess the sustainability of the PPS of the COVID-19 vaccine, we use the sustainable development analytical grid (SDAG), which is a sustainability appraisal tool, described as effective, simple, with a strong theoretical grounding, verified on policies, strategies, programs and projects at local and national levels, for over 34 years, and addresses all 17 SDGs [33]. It is an analytical tool that addresses six dimensions (ecological, social, economic, ethical, cultural and governance), subdivided into themes which themselves are split into objectives (Figure 3). The SDAG had been selected, since it involves the four principles that sustainability must answer to: equity, integration, dynamic, and normativity, and because it has the added advantage that it can be used at almost every stage and every level of the establishment of the strategy, to make sure that it is heading in the right track [33].

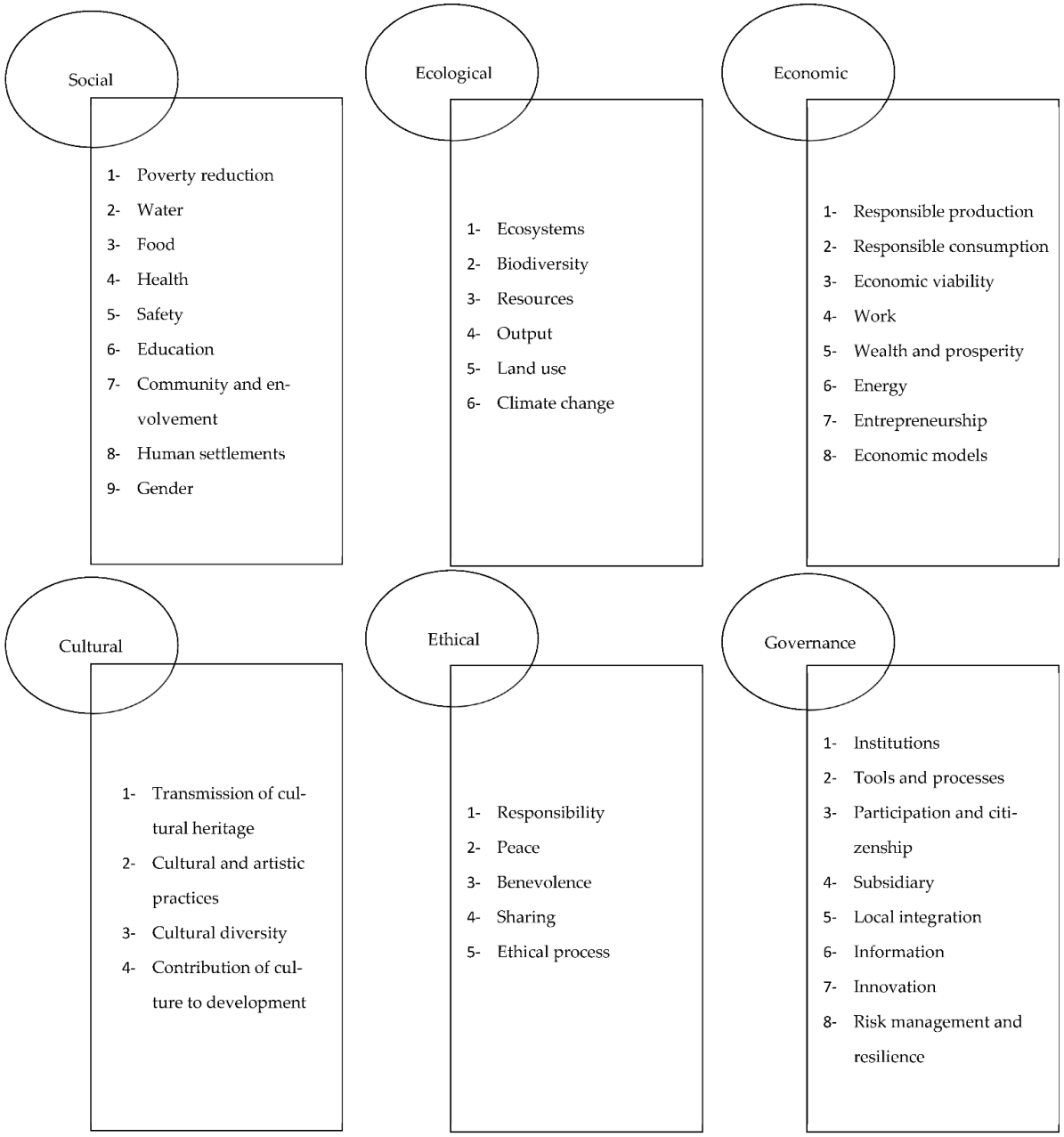

Figure 3. Dimensions and themes of the SDAG.

2.3. Methodology

Building on the framework provided, we will answer to the first question (RQ1), using an approach that brings together the widely accepted, in both literature and practice: Kraljic's purchasing portfolio model [42], Porter's five forces analysis and a multi-attribute decision making method, based on weighing up the level of importance of the different profit impact and supply risk factors.

According to Wagner et al. (2013), three factors could define the supply risk: (1) the market risk: defining the availability of the potential suppliers (2) the performance risk: setting up the quality and performance of the supplier, and (3) the complexity risk: the standardization and specification of the product [40], when the profit impact could be defined, using these three factors: (1) impact on profitability, (2) importance of the purchase and (3) value of the purchase [38].

The methodology conducted to define the PPS that should be adopted for the COVID-19 vaccine is described as follows:

1. To conduct an appropriate market research. We use Porter's five forces analysis to know how much power suppliers have, and how much purchasing power the buying country has, as their customer. Porter's five forces is a simple but powerful tool for understanding the competitiveness of the business environment, and for identifying the strategy's potential profitability. This is useful to identify the forces that can affect the profitability, in order to adjust the strategy, accordingly. Porter's five forces [43] are: competitive rivalry, supplier power, buyer power, threat of substitution, and threat of new entry.
2. Involve a multidisciplinary team of experts from key major sectors of the country concerned: public purchasers, financial and industrial experts, health officials, legal advisers, academics, etc.
3. Collect from each expert the preference score for each supply risk factor (*Pr*: a score based on 100 points). Preference scores are determined using a set of three questions [38]:
   - how much preference do you assign to the market risk, while purchasing the COVID-19 vaccine?
   - how much preference do you assign to the performance risk, while purchasing the COVID-19 vaccine?
   - how much preference do you assign to the complexity risk, while purchasing the COVID-19 vaccine?

   Then define for each supply risk factor, the corresponding preference score (*Pr*):

$$Pr = 100 \times \frac{\sum_{i=1}^{n} Pri}{n}$$

   n: number of experts;
4. Collect from the experts, the preference scores for each profit impact factor (*Pp*: a score based on 100 points). The preference scores are determined using a set of three questions [38]:
   - How much preference do you assign to the impact on profitability, while purchasing the COVID-19 vaccine?
   - How much preference do you assign to the importance of the purchase, while purchasing the COVID-19 vaccine?
   - How much preference do you assign to the value of the purchase, while purchasing the COVID-19 vaccine?

   Then define for each profit impact factor, the corresponding preference score (*Pp*)

$$Pp = 100 \times \frac{\sum_{i=1}^{n} Ppi}{n}$$

   n: number of experts;
5. Invite the experts to rate the factors, using a 10 point rating scale (1: very low to 10: very high). For each factor, the final score is the average ratings;
6. Determine the performance score;
7. Locate the purchase of the COVID-19 vaccine in the KPM;
8. Action planning.

As quoted above, to answer the second RQ related to the sustainability assessment of the PPS of the COVID-19 vaccine, we will use the SDAG, as follows:

- Preparation:

The assessment committee: it is a multidisciplinary team of experts that should conduct a dialogue exercise to give a common weighting for each goal, based on its importance within the PPS framework.

Needs analysis: is the basis for the stakeholders to understand the particularity of the operations to undertake, as they become involved in a sustainable PPS. This would have implications when weighting.

Data collection: it is obtained from the media analysis, interviews, statistical reports, official documents, and the stakeholder's declarations to public authorities.

- Weighting:

This question is asked for each objective: Is the achievement of this goal indispensable, necessary, or desirable for the success of the COVID-19 vaccine PPS?

The response is given as a numerical value that reflects the common decision of the committee, as follows (Table 1):

- Evaluation:

Table 1. Weighting of the goals (SDAG).

Weighting	Importance of the Objective
1	desirable objective: to fulfill this goal, it is not considered as significant, or is a low priority
2	necessary objective: to fulfill this goal, it is necessary, but not a top priority
3	indispensable objective: to fulfill this goal, it is imperative and is a first priority to the success of the strategy

To assess the performance of the strategy, in relation to a given objective, this question is asked for each one: How does the strategy address this objective?

The response is given as a numerical value that reflects the common score of the committee, as follows (Table 2):

Table 2. Goal assessment (SDAG).

Assessment Scale	Performance of the Strategy
0–9%	The strategy has important negative impacts on this objective.
10–19%	The strategy has moderate negative impacts on this objective.
20–29%	The strategy has negligeable negative impacts on this objective.
30–39%	The strategy does not take the objective into account, but the strategy has no impact on the objective.
40–49%	The strategy does not take the objective into account, but the strategy has indirect benefits on the objective.
50–59%	The objective is slightly considered, with no tangible measures, and minimal benefits are intended.
60–69%	The objective is moderately considered, with planned actions, but with no innovative elements.
70–79%	Concrete actions and some innovative elements are implemented within this objective, benefits are intended.
80–89%	Innovations and concrete measures are implemented within this objective, important benefits are intended.
90–100%	This objective is strongly considered, and the strategy is a model in that respect.

The assessment scores are justified by the planned or implemented actions, and the opportunities for improvement are suggested by the committee, on the basis of a brainstorming session.

- Results interpretation:

A grid for prioritizing the objectives is used to give a qualitative interpretation of the findings, as Figure 4:

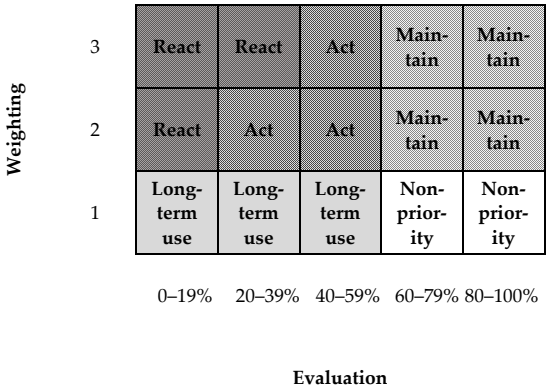

Figure 4. Prioritization of goals within the SDAG. Source: from Villeneuve et al. (2016) [33].

3. Results

3.1. Purchasing strategy

3.1.1. Market research

Purchase classification:

The KPM classifies purchases, based on both internal and external dimensions, when the agreement negotiations started (April 2020):

Internal factors:

- Impact on growth: according to a study published by the Moroccan Central Bank that analysed, inter alia, the impact of COVID-19 pandemic on the economy, the economic growth in 2020 was estimated at approximatively 6 pts below what it was before COVID-19. The overall cost of the crisis would be around MAD 40 billion. Within this context, the Moroccan Health Ministry announced the purchase of COVID-19 vaccines, through international agreements. The aim of this purchase is a gradual return to normality of the global gross domestic product (GDP). Thus, the purchase of the COVID-19 vaccine has a very important impact on Morocco's growth;
- Volume purchased: the original order of 65 million doses of the COVID-19 vaccine covered, as it has been reported, 40 million from Sinopharm and 25 million from AstraZeneca. The purchase agreements include confidentiality, and prices cannot be disclosed. The volume purchased, as calculated in Table 3, remains approximate. As it turns out, for the same COVID-19 vaccine, prices are different from one country to another. We assume that the price for a complete vaccination (two doses) of AstraZeneca is EUR 10 (≈USD 11.90) and Sinopharm is EUR 30 (≈USD 35.70). The basis of the calculation of the logistic costs is the COVAX working group's update estimate on the delivery charges in 92 AMC countries [44]. Supply costs are estimated to stand at around USD 1.66 per dose delivered and USD 3.70 for a complete vaccination (two doses) after taking the vaccine wastage into account (Table 3).

Table 3. Estimated cost of the initial COVID-19 vaccine order.

	Number of Doses Ordered	Price (USD) for a Complete Vaccination (Two Doses)	Price (USD) of One Dose	Total Amount (MAD) (USD 1 ≈ MAD 8.92)
AstraZeneca	25,000,000	11.90 (*)	5.95	1,326,850,000
Sinopharm	40,000,000	35.70 (*)	17.85	6,368,880,000
Logistic costs	65,000,000	3.70	1.85	1,072,630,000
Total amount (MAD)				8,768,360,000

(*) These prices were announced by the former Moroccan prime minister, in an interview.

It is important to note that the COVID-19 vaccine purchasing budget represents 85% of the entire budget of the Moroccan Health Ministry, excluding personnel costs (Finance Law 2021), which means that the volume to purchase is very significant.

External factors:

Currently available COVID-19 vaccines are approved on an emergency or conditional basis, then the procurement bodies, such as governments and supranational organizations are confronting two major risks: (1) to guarantee that they would quickly meet the vaccine needs for the eligible population; (2) uncertainty concerning the efficacy of the vaccine against emerging and future COVID-19 variants.

Thus, the vaccine procurement has a significant supply risk, especially since its availability and the number of its suppliers are very limited, in view of the great international demand.

Porter's Five Forces analysis:

We assimilate Morocco to a firm, the COVID-19 vaccine to its marketed product, the manufacturers to its suppliers and its citizens to buyers.

- Competitive rivalry: initially, it is a market with lots of rivals, suppliers can go elsewhere if they feel that they are not receiving a good deal from the buyer. In 2021,

the largest COVID-19 vaccine share, in terms of value, was held by North America, followed by Europe, and Africa had the smallest market share. Supplier's power: The number of suppliers is currently very limited, compared to the number of countries that need to be covered, which grants a strong bargaining power to the suppliers. However, significant doubts can affect the production and supply of the vaccine, such as the uncertainties on the approvals that impact the number of doses available and the rate of effectiveness that helps to determine the number of doses per person. Thus, the strong supplier position is subject to change in the case of new entrants into the COVID-19 vaccine market. The more suppliers are available, the easier it will be to switch to a cheaper alternative that represents a lower total cost of ownership. However, the fewer suppliers there are, the more their help is needed, and the stronger their position is.

- Buyer's Power: In the context of the present paper, the buyer's power is not about the risk to switch from a company's products or services to those of a rival, it rather concerns the risks involved by a people's power, if the vaccine is not provided. Access to the vaccine is a human right. Not making the vaccine available to citizens could be interpreted as a failure of the country to respect and protect the fundamental right to access to the vaccine. Given the interconnected nature of the risks, each individual risk has the potential to create ripple effects by provoking other risks. According to the global risk interconnexions map (2020) a risk of infectious diseases will inevitably have a direct effect on social instability, budgetary crises, collapse of the state [45], etc., therefore it is important to vaccinate citizens, in order to limit the damages that the pandemic could do from an economical, societal, geopolitical, environmental, and technological point of view. Thus, the people's power, buyer's power, is high.
- Threat of substitution: there is no effective drug treatment known, so far [46]. However, it is necessary to establish a strategic watch.
- Threat of a new entry: as long as the COVID-19 vaccine is free of charge, there will be no threat of new entrants.

The diagram of Porter's five forces is mapped in Figure 5 below:

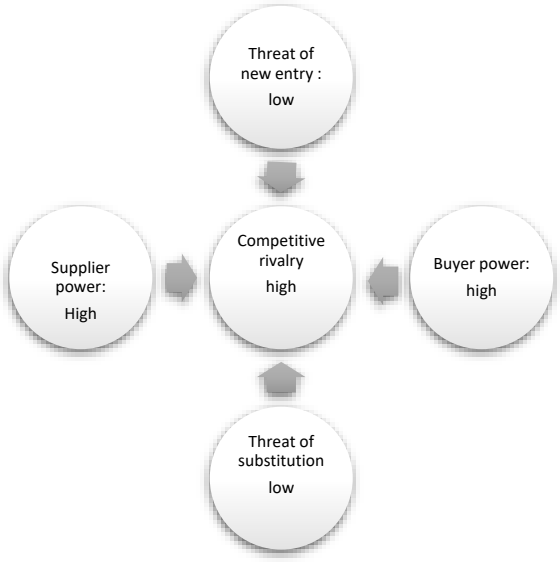

Figure 5. Porter's Five Forces.

3.1.2. Work group:

To conduct this case study, we worked closely with a cross-functional team, composed of ten experts from different stakeholder institutions from Morocco, as detailed in Table 4 below:

Table 4. PPS team work.

Expert	Function	Institution
E1	Purchasing manager	Health Ministry
E2	Budget manager	Health Ministry
E3	Purchasing manager	Ministry of Economy and Finance
E4	Senior legal expert	Ministry of Economy and Finance
E5	Risk officer	Banking sector
E6	Risk manager	Public service for long term savings and fund management business
E7	Professor of medicine	Faculty of Medicine
E8	Professor of strategic management	Faculty of Economics and Management
E9	Budget manager	Ministry of Labour and Professional Inclusion
E10	Purchasing manager	Ministry of Industry and Trade

3.1.3. Normalized Preference Scores for Each Supply Risk Factor

The preference scores for each supply risk factor are collected from the experts, as shown in Table 5 below:

Table 5. Normalized preference scores for the supply risk factors.

Supply Risk Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Normalized Preference Scores Supply Risk
market risk	40	45	50	40	25	40	30	45	40	80	43.50%
performance risk	40	40	25	50	25	50	35	35	40	10	35.00%
complexity risk	20	15	25	10	50	10	35	20	20	10	21.50%

3.1.4. Normalized Preference Scores for Each Profit Impact Factor

The preference scores for each profit impact factor are collected from the experts, as shown in Table 6 below:

Table 6. Normalized preference scores for the profit impact factors.

Profit Impact Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Normalized Preference Scores Profit Impact
Impact on profitability	30	40	40	40	60	30	30	50	25	25	37.00%
Importance of purchase	30	20	30	40	30	20	50	20	25	25	29.00%
Value of purchase	40	40	30	20	10	50	20	30	50	50	34.00%

3.1.5. Rating of the Supply Risk and Profit Impact

Rating of the purchase of the COVID-19 vaccine, depending on the supply risk and the profit impact, as follows (Table 7):

Table 7. Factors' rating.

	Supply Risk Rating			Profit Impact Rating		
	Market Risk	Performance Risk	Complexity Risk	Impact on Profitability	Importance of the Purchase	Value of the Purchase
E1	9	9	6	8	8	10
E2	7	7	7	9	9	10
E3	7	8	6	8	7	9.5
E4	7	8	8	9	9	9
E5	6	5	10	5	5	8
E6	10	7	3	7	8	3
E7	7	8	8	7	9	7
E8	7	7	7	8	7	9
E9	7	7	6	9	9	9
E10	9	10	5	7	7	10
Average	7.6	7.6	6.6	7.7	7.8	8.45

3.1.6. Performance Score

Equal priority is given to the supply risk and profit impact, the weighted average is then divided by two, so as to obtain the global average, as follows (Table 8).

Table 8. Performance score.

Average Supply Risk		Average Profit Impact	
Weighted Average	**Global Average**	**Weighted Average**	**Global Average**
7.39	3.69	7.98	3.99

3.1.7. Visual Positioning

It can be seen from the above that the purchase of the COVID-19 vaccine is located in the strategic quadrant of the KPM (see Figure 6), which means that it deserves a special attention from the purchasing managers. These items should be bought on the basis of total cost, instead of price, and involve a more collaborative approach from both the seller and the buyer [37]. We distinguish three different scenarios:

1. Early in the pandemic, the supply market strength is at its peak, due to the high demand around the world, and the fact that the number of COVID-19 vaccines' suppliers is limited. Which decreases the power of the Moroccan government as a buyer (high supply market strength VS low strength as a buyer).
2. In the short term, as world production would be higher, global competition over the vaccine would be lower, increasing the strength of Morocco as a buyer (medium supply market strength Vs medium strength as a buyer) [47].
3. Alternatively, over the medium-term, the worldwide production capacity would exceed global demand. This could reduce the supply market strength and enhance Morocco's negotiating power (low supply market strength VS great strength as a buyer).

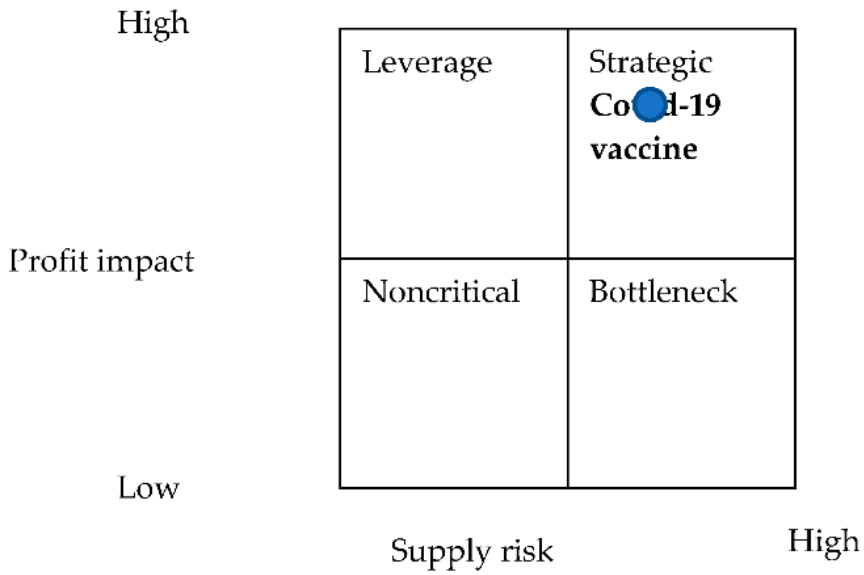

Figure 6. Purchase of the COVID-19 vaccine-KPM.

3.1.8. Action Plans

Finally, we are going to develop action plans for each of the specific cases, according to where they are placed in the purchasing portfolio matrix (Figure 2).

Each of the three strategic thrusts has distinctive implications for the individual elements of the PPS.

According to the purchasing portfolio matrix, the strategy to adopt is:

1. to diversify currently, that is, to reduce the supply risks by seeking alternative suppliers or alternative products, therefore a strategic watch is needed. Consolidating to a single supplier can increase the buying power significantly [48]. Bringing the production in-house, if possible, might be beneficial;

2. to balance, in the short term, which means to take a middle path between the exploitation approach and the diversification approach;
3. to exploit in the middle term, that is, to take advantage of the high buying power to secure good prices from several suppliers, so that the supply risk involved is reduced. Spot purchases might be beneficial, if a particular supplier offers a good deal. The only real caution would be to not engage in any aggressive approach against the suppliers and stay on good terms, in case of a sudden change in circumstances.

3.2. Sustainability of the PPS

It took eight working meetings to achieve the assessment. The assessment Committee included five experts in the related fields, in addition to the author as a facilitator, as follows (Table 9):

Table 9. Assessment Committee.

Expert	Function	Business Sector
E1	Communication manager	Energy sector
E2	Budget manager	Social sector
E3	Legal expert	Cultural field
E4	Risk manager	Finance sector
E5	Purchasing manager	Public administration

The first meeting was held to discuss the method of the analysis, based on the reference documents of the SDAG. Each of the six following meetings was devoted to a specific dimension. The last meeting was about discussing the results.

For each of the 166 objectives, a consensus weighting was defined, then the performance was assessed.

Figure 7 below, shows that for the PPS of the COVID-19 vaccine, 39% of the objectives are indispensable, 40% are important and 21% are desirable, but not a priority within the framework of the PPS. The social and economic dimensions are those that contain the largest number of indispensable objectives.

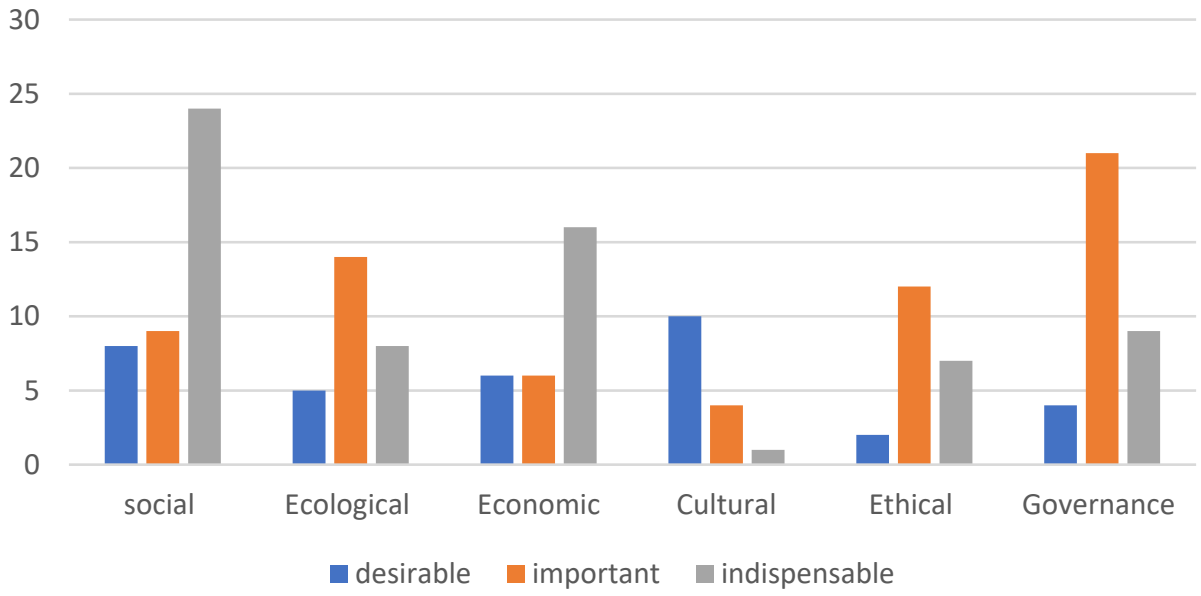

Figure 7. Weighting distribution.

Thirteen themes have an average weighting ≥2.5, as shown in Table 10, they represent the highest priority themes of the PPS of the COVID-19 vaccine.

Table 10. Average weighting for the dimensions and themes of the PPS.

Dimension/Theme	Average Weighting	Dimension/Theme	Average Weighting
Social	**2.4**	**Economical**	**2.4**
Poverty reduction	2.3	Responsible production	3.0
Water	2.0	Responsible consumption	3.0
Food	2.0	Economic viability	2.8
Health	2.8	Work	2.5
Safety	3.0	Wealth and prosperity	2.5
Education	2.2	Energy	1.3
Community involvement	2.7	Entrepreneurship	1.3
Human settlements	2.0	Economic models	2.0
Gender	2.7	**Cultural**	**1.4**
Ecological	**2.1**	Transmission of cultural heritage	1.2
Ecosystems	1.8	Cultural and artistic practices	2.0
Biodiversity	1.7	Cultural diversity	1.3
Resources	2.2	Contribution of culture to development	1.0
Output	2.8	**Governance**	**2.1**
Land use	2.0	Institutions	1.5
Climate change	2.0	Tools and processes	2.0
Ethical	**2.2**	Participation and citizenship	2.1
Responsibility	2.3	Subsidiary	2.7
Peace	2.3	Local integration	2.0
Benevolence	2.3	Information	1.8
Sharing	1.7	Innovation	2.4
Ethical process	2.5	Risk management and resilience	2.6

The assessment score, assigned by the committee to each objective, is the average of the individual scores, justified by the planned or implemented actions. Table 11 shows the performance of the SD dimensions:

Table 11. Performance of the SD dimensions.

Dimension	Average Performance
Economic	77%
Social	74%
Governance	73%
Ethical	73%
Ecological	59%
Cultural	57%

The economic dimension (Figure 8) scored the highest (77%). It is greatly influenced by the importance given by the PPS, to a responsible consumption (87%), in view of the equitable way in which the distribution of the COVID-19 vaccine is managed. Local manufacturing of the vaccine would promote a responsible production (85%).

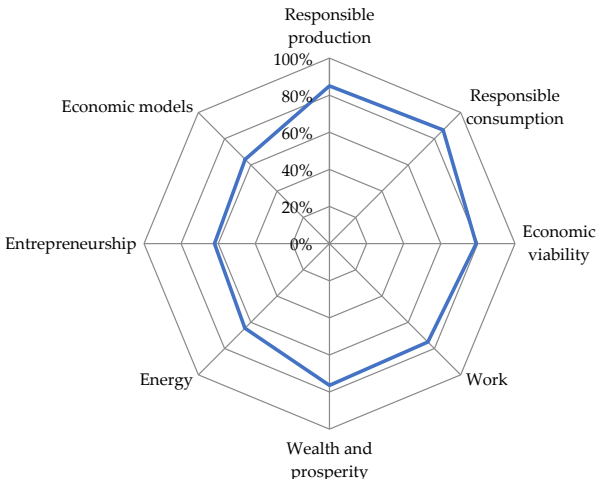

Figure 8. Performance of the economic dimension.

The social dimension (Figure 9) scored 74%, given the direct relationship between the COVID-19 vaccine and health objectives, and since the vaccine distribution fulfils the principles of non-discrimination and gender equality.

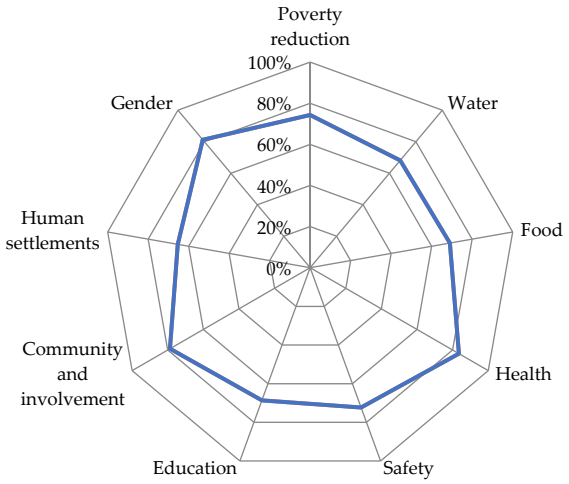

Figure 9. Performance of the social dimension.

The governance dimension (Figure 10) scored 73%. Its average performances range between 62% for information and 79% for participation and citizenship. The rate of the information theme is due to the fact that despite the significant number of communication campaigns to promote immunization, only very limited information was released about the procurement process of the COVID-19 vaccine. The high rate of participation and citizenship is the result of the various developed partnerships, such as the public-private partnership to manage the logistics of the immunization campaign, the interdepartmental partnership for the pandemic overall management, and the partnership with Sinophatm et Recipharm for the local manufacturing of the COVID-19 vaccine.

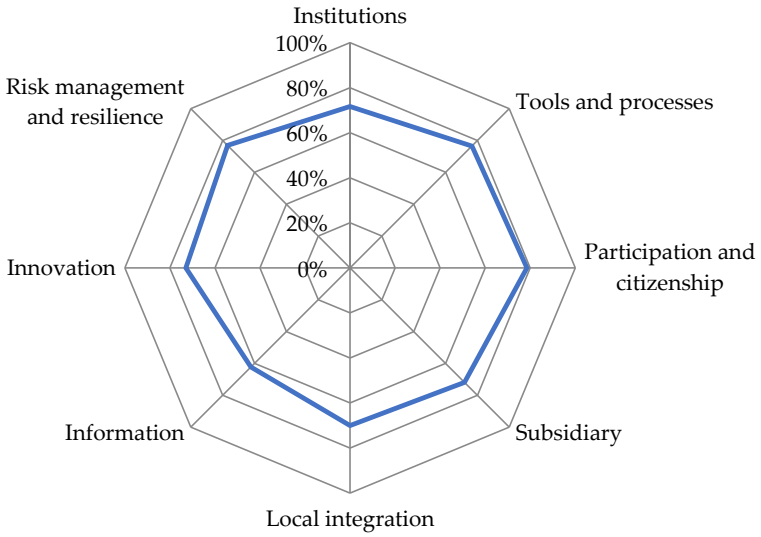

Figure 10. Performance of the governance dimension.

The ethical dimension (Figure 11) also scored 73%. The highest average performance is that of the responsibility theme given: the fair and responsible distribution of the COVID-19 vaccine, all of the levels of control at every stage of the vaccine's lifecycle and the respect for human rights, including the fundamental right to health care.

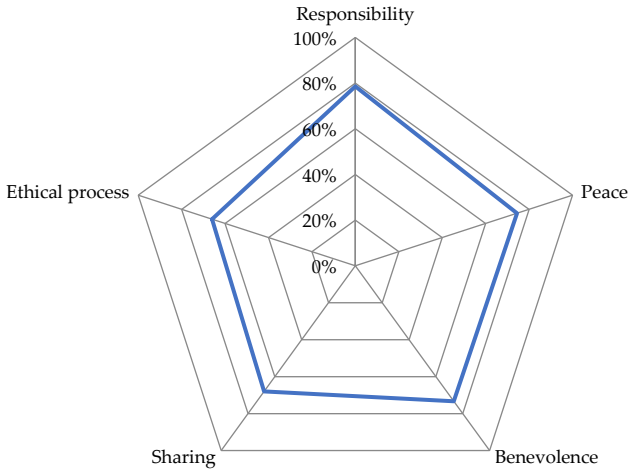

Figure 11. Performance of the ethical dimension.

The ecological dimension (Figure 12) is in the fifth position, with very homogeneous average performances, marked by a slight increase of the theme of climate change (64%), due to the fact that purchasing the vaccine helps reducing the negative ecological impacts, related to hospitalization from COVID-19, besides implementing production units of the vaccine would decrease the carbon footprint related to the vaccine transportation.

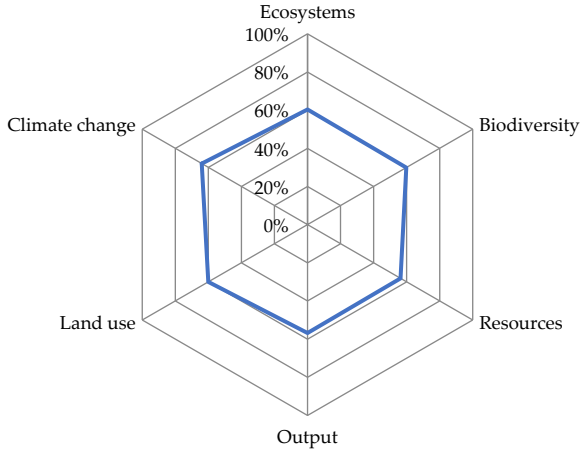

Figure 12. Performance of the ecological dimension.

The cultural dimension (Figure 13) ranks last (57%). Although desirable, its objectives were not considered by the committee members as a priority, at this stage. Arts and cultural events were indeed banned during the lockdown, and have ever since been subject to restrictions. Vaccination could be the one solution to start over.

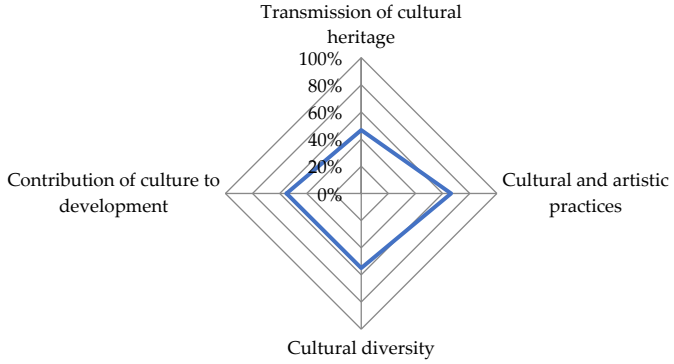

Figure 13. Performance of the cultural dimension.

This analysis was used to identify the goals that should be prioritized to enhance the SD performance of each theme of the strategy.

The majority of actions planned or already implemented, are deemed satisfactory (123 out of 166). Twenty-one percent of the objectives are long term issues, as is the case of most objectives from the cultural dimension. Five percent require a sustained program of action. This affects six ecological objectives of the themes termed "output" and resources" and the two social objectives of the themes termed "health and safety" (Figure 14).

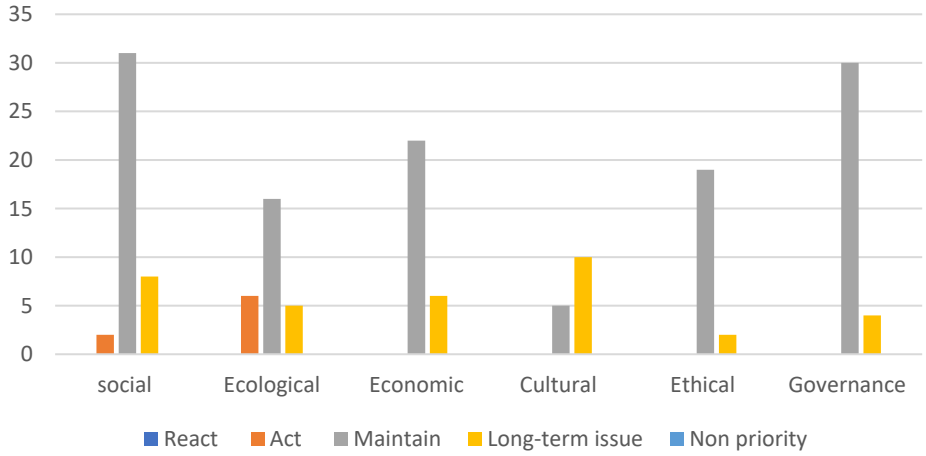

Figure 14. Prioritizing the themes.

4. Discussion

The main objective, was to be able to obtain vaccine doses to save lives, in a pandemic context, characterized by an upsurge in demand and the scarcity of supply (vaccine availability being treated as having a much higher priority than cost). In order to have a stronger negotiating position, the Moroccan government used its diplomatic relationships with vaccine producing countries, as part of its procurement strategy. This has allowed Morocco to become the first African country to start a major vaccination campaign.

Morocco had also been involved in the clinical trials of Sinopharm's vaccine, to guarantee its share of it. The COVID-19 vaccine campaign was initially scheduled to start in November 2020 but had to be postponed for two months (29 January 2021), due to delivery delays. In fact, at this time, the market was at its peak and Morocco's bargaining power as a buyer was very low.

Deliveries from AstraZeneca were interrupted, due to the health situation in India, whereas deliveries from Sinopharm started slowly, due to intense competitive rivalry, then turned relatively regular. That explains Morocco's strategic move (starting from the 13 August 2021), as they introduced Pfizer as a new additional supplier, as an attempt to diminish the exclusive buying power of Sinopharm.

Morocco is currently particularly relying on Sinopharm and Pfizer because they give visibility of the delivery schedule (Figure 15).

Furthermore, Morocco has launched a project for bringing production and syringe filling of the vaccines in house, including the COVID-19 vaccine, in response to the potential risks linked to: (1) the emergence of new viral variants, resulting from new strains and virus mutations, (2) vaccine scarcity, (3) newly emerging epidemics. Morocco hopes to improve the production capacity for a more sustainable and reliable vaccine supply. This is a strategic investment, as it would enable self-sufficiency, access to the African markets, and above all to the creation of an ecosystem of industries of biotechnology and biosimilars that will involve boosting skills and attracting potential investors.

Thus, in reply to RQ3, Morocco has so far complied with the first scenario of the PPS of the COVID-19 vaccine described earlier.

It should be noted that despite the competitive rivalry, until March 23, 2022, Morocco was able to fully vaccinate (two doses) 63.3% of its population.

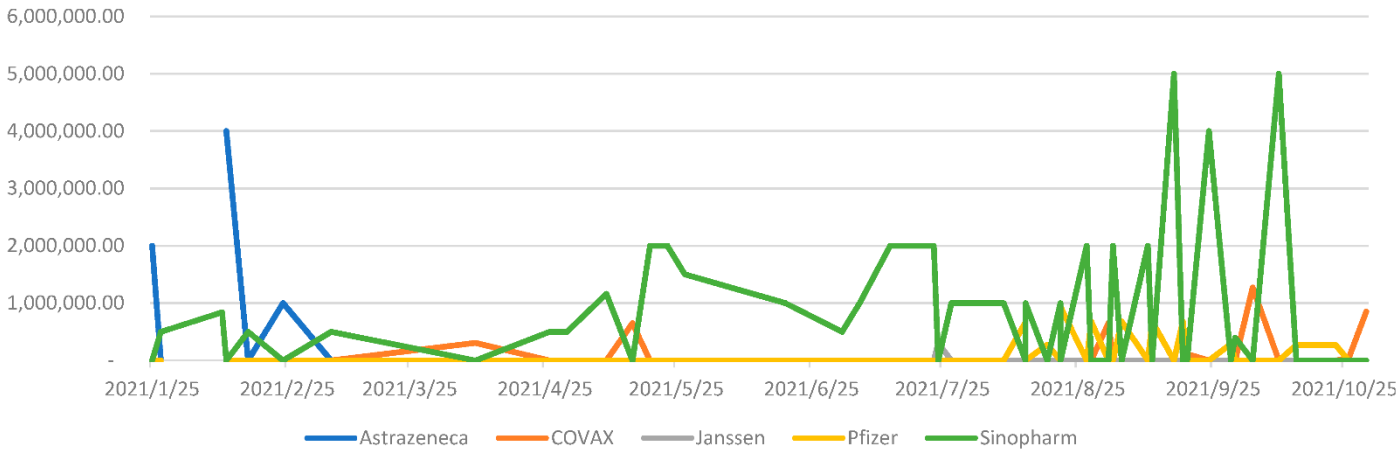

Figure 15. Deliveries by supplier, from 1 January 2021 to 30 October 2021.

The main aim, at present, must be to switch from the strategic quadrant to the leverage quadrant, since leverage purchases are easy to manage, despite their strategic importance [49].

Due to the COVID-19 crisis, 1.058 million people are facing a major threat, as they are on the verge of joining the vulnerable into poverty [50]. Morocco adopted its PPS to ensure economic recovery, reduce poverty, and enable citizens to have access to basic needs, such as water, food, and energy. Knowing that, the disruption of the global supply chains and international maritime transport, caused the price increase of some basic foodstuffs.

Education has also been impacted negatively by the crisis. During the lockdown, 18% of households (29% of which in rural areas) could not participate in distance-learning classes. Then, the PPS is of vital importance to protect the gains made so far on school enrolment and literacy.

However, the COVID-19 vaccine rollout created a false sense of security. A degree of relaxation in the application of shielding measures was observed. The arrival of new variants generates an explosion in the number of cases. Thus, it is important to enhance the communication strategy with an approach, focused on each class, to increase awareness on protection measures.

To ensure the COVID-19 vaccine supply, significant efforts were made regarding governance, such as the creation of partnerships between different stakeholders. The appointment scheduling system of the COVID-19 vaccine ensures a successful organization and limits the opportunities for corruption.

An immunization awareness campaign was developed on multiple media platforms. However, it is important to review the project communication strategy through adopting a better targeted and more positive approach and opting for more transparency, in particular for information related to the vaccine procurement process. A better tailored health communication is also needed to face misinformation about the vaccine, vaccine hesitancy and antivax movements.

With regard to the environmental pillar, the knowledge and experience of Morocco are used for the waste management of the vaccine. Renewable energy is a major component of the Moroccan energy strategy. This is an opportunity to achieve SD along climate-resilient and low greenhouse gas emission-intensive paths, limiting the use of fossil fuels, investing in less harmful refrigerants and recycling empty vaccine vials.

To answer RQ4, the SA shows that the PPS of the COVID-19 vaccine covers satisfactorily 74% of the 166 SDGs addressed by the SDAG. Five percent of the objectives immediately need an additional plan of action, while 21% of issues can only be dealt with over the longer term, given the urgency of the economic and social recovery.

In the same framework, for a better assessment, it would be appropriate to make a comparison with another similar strategy, in terms of the context and needs.

Furthermore, given the dynamic nature of the SA, the PPS needs to be periodically evaluated, in order to follow up, adjust, correct and maintain its accomplishments.

5. Conclusions

The article provides useful insights for other developing countries, in order to set up a COVID-19 vaccine PPS and to assess its sustainability. It is also valuable for academics, public purchasing managers, and all the stakeholders involved in the public procurement process, who need an overview about how to develop a PPS, in times of crisis or scarcity.

The first purpose of the case study was to determine the best purchasing strategy to be adopted by Morocco for the COVID-19 vaccine, using Kraljic's portfolio matrix (KPM). It was found that the PPS should be based on three different scenarios, according to the worldwide demand, whose progress was assessed via Porter's five forces analysis.

The study reported that Morocco's approach is up to date, in line with the first scenario of the theoretical strategy, namely the diversification to reduce the dependence on a single supplier, and bringing the production in house, in the framework of the ongoing project of the production and syringe filling of vaccines, including the COVID-19 vaccine.

Defining the purchasing strategy of the COVID-19 vaccine that should be adopted by Morocco, provides another illustration of the power of the KPM, as a dynamic and flexible tool that needs to be reviewed frequently, because of the dynamic nature of the markets that can change the supply situation significantly in short time periods.

The procurement strategy was then assessed, in terms of sustainability, and using the SDAG, it would appear that the strategy provides coverage for most of the objectives, but considering the urge for an economic reboot, some fields are to be prioritized while others would only be considered later on in a long-term vision. It would also appear that the SDAG brings in some improvement options, including some clues that seem to have appeared on multiple occasions reaching multiple dimensions. A periodical sustainability assessment is a key factor in achieving a continuous improvement of the strategy.

However, several important lessons could be drawn from the PPS adopted by Morocco and developed in this paper: aware of the key role of immunization to save human lives and to restart the economy, Morocco established a PPS to purchase an adequate number of COVID-19 vaccines, in a pandemic context characterized by very strong global demand and an extremely short supply of doses. Then, achieving the first step of the strategy, which consists of diversification to decrease the dependence on a single supplier, wasn't easy. To do that, Morocco used its instruments and diplomatic relations with vaccine producing countries to be in a stronger negotiating position, Morocco has also hosted the clinical trials of Sinopharm's vaccine, to guarantee its share of it.

To ensure vaccine sovereignty, Morocco set up a first production unit for a more sustainable and reliable vaccine supply, as a second step of its PPS. The essential aim of this investment is self-sufficiency and to better respond to the needs of vaccines of the African continent.

The actions taken by Morocco in the procurement of the COVID-19 vaccine have made it possible to turn pandemic challenges into an opportunity to create an ecosystem of industries of biotechnology and biosimilars.

In future research, the PPS should be updated in accordance with supply and demand, the sustainability assessment should be actualized too. This paper can be regarded as a starting point for further discussions about drivers and barriers of sustainable procurement in Morocco, that could be enriched by a benchmark [51], and sustainability assessment of strategic projects.

Author Contributions: Conceptualization, H.T.B.; Methodology, H.T.B.; Formal analysis, H.T.B.; Investigation, H.T.B.; Supervision, Z.B. and H.H.; Funding acquisition, H.T.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Uyarra, E.; Flanagan, K. Understanding the innovation impacts of public procurement. *Eur. Plan. Stud.* **2010**, *18*, 123–143. [CrossRef]
2. Bosio, E.; Djankov, S.; Glaeser, E.L.; Shleifer, A. Public procurement in law and practice (No. w27188). *Am. Econ. Rev.* **2022**, *112*, 1091–1117. [CrossRef]
3. Thai, K.V. Public procurement re-examined. *J. Public Procure.* **2001**, *1*, 9–50. [CrossRef]
4. Benchekroun, H.T.; Benmamoun, Z.; Hachimi, H. Sustainable Procurement in the Public Sector Case study of Morocco. In Proceedings of the International Conference on Industrial Engineering and Operations Management, Pilsen, Czech Republic, 23–26 July 2019.
5. Accounts Chamber of the Russian Federation. *Public Procurement during the COVID-19 Pandemic: Digest Prepared by the Department for International and Regional Cooperation of the Accounts Chamber of the Russian Federation*; Accounts Chamber of the Russian Federation: Moscow, Russia, 2020.
6. Brammer, S.; Walker, H. Sustainable procurement in the public sector: An international comparative study. *Int. J. Oper. Prod. Manag.* **2011**, *31*, 452–476. [CrossRef]
7. Kim, J.H.; Marks, F.; Clemens, J.D. Looking beyond COVID-19 vaccine phase 3 trials. *Nat. Med.* **2021**, *27*, 205–211. [CrossRef] [PubMed]
8. Shahed, K.S.; Azeem, A.; Ali, S.M.; Moktadir, M.A. A supply chain disruption risk mitigation model to manage COVID-19 pandemic risk. *Environ. Sci. Pollut. Res.* **2021**, 1–16. [CrossRef]
9. OECD. *OECD Policy Responses to Coronavirus (COVID-19). Public Procurement and Infrastructure Governance: Initial Policy Responses to the Coronavirus (COVID-19) Crisis*; OECD: Paris, France, 2020.
10. Gianfredi, V.; Filia, A.; Rota, M.C.; Croci, R.; Bellini, L.; Odone, A.; Signorelli, C. Vaccine Procurement: A Conceptual Framework Based on Literature Review. *Vaccines* **2021**, *9*, 1434. [CrossRef]
11. Moubarack, L.; Amaye, S. La vaccination peut-elle guérir le monde de la Covid-19? Etude de cas de quelques pays. *Africaportal* **2021**. Available online: https://www.africaportal.org/publications/la-vaccination-peut-elle-guerirle-monde-dela-covid-19-etude-de-cas-dequelques-pays-can-vaccination-cure-world-covid-19-country-case-studies/ (accessed on 15 November 2022).
12. DeRoo, S.S.; Pudalov, N.J.; Fu, L.Y. Planning for a COVID-19 vaccination program. *JAMA* **2020**, *323*, 2458–2459. [CrossRef]
13. Abbasi, B.; Fadaki, M.; Kokshagina, O.; Saeed, N.; Chhetri, P. Modeling vaccine allocations in the COVID-19 pandemic: A case study in Australia. *SSRN Electron. J.* **2020**, 3744520. [CrossRef]
14. Alam, S.T.; Ahmed, S.; Ali, S.M.; Sarker, S.; Kabir, G. Challenges to COVID-19 vaccine supply chain: Implications for sustainable development goals. *Int. J. Prod. Econ.* **2021**, *239*, 108193. [CrossRef] [PubMed]
15. Phelan, A.L.; Eccleston-Turner, M.; Rourke, M.; Maleche, A.; Wang, C. Legal agreements: Barriers and enablers to global equitable COVID-19 vaccine access. *Lancet* **2020**, *396*, 800–802. [CrossRef] [PubMed]
16. Montgomery, R.T.; Ogden, J.A.; Boehmke, B.C. A quantified Kraljic Portfolio Matrix: Using decision analysis for strategic purchasing. *J. Purch. Supply Manag.* **2018**, *24*, 192–203. [CrossRef]
17. Watermeyer, R.B. A framework for developing construction procurement strategy. *Proc. Inst. Civ. Eng. Manag. Procure. Law* **2012**, *165*, 223–237. [CrossRef]
18. Dubois, A.; Pedersen, A.C. Why relationships do not fit into purchasing portfolio models—A comparison between the portfolio and industrial network approaches. *Eur. J. Purch. Supply Manag.* **2002**, *8*, 35–42. [CrossRef]
19. Lin, Q.; Zhao, Q.; Lev, B. Influenza vaccine supply chain coordination under uncertain supply and demand. *Eur. J. Oper. Res.* **2022**, *297*, 930–948. [CrossRef]
20. Possas, C.; de Souza Antunes, A.M.; de Oliveira, A.M.; de Souza Mendes Santos, C.D.U.; Ramos, M.P.; de Oliveira Rodrigues Schumacher, S.; Homma, A. Vaccine innovation for pandemic preparedness: Patent landscape, global sustainability, and circular bioeconomy in post-COVID-19 era. *Circ. Econ. Sustain.* **2021**, *1*, 1439–1461. [CrossRef]
21. Grace, C. *Developing New Technologies to Address Neglected Diseases: The Role of Product Development Partnerships and Advanced Market Commitments*; Department for International Development (DFID) Health Research Center Report: London, UK, 2006.
22. Neumann, P.J.; Cohen, J.T.; Kim, D.D.; Ollendorf, D.A. Consideration Of Value-Based Pricing For Treatments And Vaccines Is Important, Even In The COVID-19 Pandemic: Study reviews alternative pricing strategies (cost-recovery models, monetary prizes, advanced market commitments) for COVID-19 drugs, vaccines, and diagnostics. *Health Aff.* **2021**, *40*, 53–61.
23. Jiang, P.; Klemeš, J.J.; Van Fan, Y.; Fu, X.; Tan, R.R.; You, S.; Foley, A.M. Energy, environmental, economic and social equity (4E) pressures of COVID-19 vaccination mismanagement: A global perspective. *Energy* **2021**, *235*, 121315. [CrossRef]
24. Klemeš, J.J.; Jiang, P.; Van Fan, Y.; Bokhari, A.; Wang, X.C. COVID-19 pandemics Stage II–energy and environmental impacts of vaccination. *Renew. Sustain. Energy Rev.* **2021**, *150*, 111400. [CrossRef]

25. Hasija, V.; Patial, S.; Raizada, P.; Thakur, S.; Singh, P.; Hussain, C.M. The environmental impact of mass coronavirus vaccinations: A point of view on huge COVID-19 vaccine waste across the globe during ongoing vaccine campaigns. *Sci. Total Environ.* **2022**, *813*, 151881. [CrossRef]
26. Robert, K.W.; Parris, T.M.; Leiserowitz, A.A. What is sustainable development? Goals, indicators, values, and practice. *Environ. Sci. Policy Sustain. Dev.* **2005**, *47*, 8–21. [CrossRef]
27. Janker, J.; Mann, S. Understanding the social dimension of sustainability in agriculture: A critical review of sustainability assessment tools. *Environ. Dev. Sustain.* **2020**, *22*, 1671–1691. [CrossRef]
28. Benchekroun, H.T.; Benmamoun, Z.; Hachimi, H. How to select suppliers when implementing a sustainable procurement strategy. In Proceedings of the 2019 5th International Conference on Optimization and Applications (ICOA), Kenitra, Morocco, 25–26 April 2019; pp. 1–4.
29. Bulin, D.; Oehler-Sincai, I.M.; Kanovici, A.L.; Iorgulescu, M.C.; Popescu, C.; Popescu, D. Interpretation of Sustainable Development Using a Set of Macroeconomic and Social Indicators for a Group of Nine Emerging Economies. *Sustainability* **2019**, *11*, 3095.
30. Devuyst, D.; Hens, L.; Lannoy, W.D. *How Green Is the City? Sustainability Assessment and the Management of Urban Environments*; Columbia University Press: New York, NY, USA, 2001.
31. Bragança, L.; Mateus, R.; Koukkari, H. Building sustainability assessment. *Sustainability* **2010**, *2*, 2010–2023. [CrossRef]
32. Verheem, R.; Tonk, J. Strategic environmental assessment: One concept multiple forms. *Impact Assess. Proj. Apprais.* **2000**, *18*, 177–182. [CrossRef]
33. Villeneuve, C.; Tremblay, D.; Riffon, O.; Lanmafankpotin, G.Y.; Bouchard, S. A systemic tool and process for sustainability assessment. *Sustainability* **2017**, *9*, 1909. [CrossRef]
34. Hacking, T. The SDGs and the sustainability assessment of private-sector projects: Theoretical conceptualisation and comparison with current practice using the case study of the Asian Development Bank. *Impact Assess. Proj. Apprais.* **2019**, *37*, 2–16. [CrossRef]
35. Gasparatos, A. Embedded value systems in sustainability assessment tools and their implications. *J. Environ. Manag.* **2010**, *91*, 1613–1622. [CrossRef]
36. Amine, A.; Lazzaoui, N. Shoppers' reactions to modern food retailing systems in an emerging country: The case of Morocco. *Int. J. Retail. Distrib. Manag.* **2011**, *39*, 562–581. [CrossRef]
37. Gelderman, C.J.; Van Weele, A.J. Purchasing portfolio models: A critique and update. *J. Supply Chain. Manag.* **2005**, *41*, 19–28. [CrossRef]
38. Wagner, S.M.; Padhi, S.S.; Bode, C. The procurement process. *Ind. Eng.* **2013**, *45*, 34–39.
39. Kraljic, P. Purchasing Must Become Supply Management. *Harv. Bus. Rev.* **1983**, *61*, 109–117.
40. Perdana, A.; Mulyono, N.B. Purchasing Strategies in the Kraljic Portfolio Matrix–a Case Study in Open Pit Coal Mining. *Indones. Min. Prof. J.* **2021**, *3*, 45–58. [CrossRef]
41. Bianchini, A.; Benci, A.; Pellegrini, M.; Rossi, J. Supply chain redesign for lead-time reduction through Kraljic purchasing portfolio and AHP integration. *Benchmarking Int. J.* **2019**, *26*, 1194–1209. [CrossRef]
42. Caniels, M.C.; Gelderman, C.J. Purchasing strategies in the Kraljic matrix—A power and dependence perspective. *J. Purch. Supply Manag.* **2005**, *11*, 141–155. [CrossRef]
43. Knudsen, D. Aligning corporate strategy, procurement strategy and e-procurement tools. *Int. J. Phys. Distrib. Logist. Manag.* **2003**, *33*, 720–734. [CrossRef]
44. Costs of Delivering COVID-19 Vaccine in 92 AMC Countries. Available online: https://www.who.int/docs/default-source/coronaviruse/act-accelerator/covax/costs-of-covid-19-vaccine-delivery-in-92amc_08.02.21.pdf (accessed on 8 February 2020).
45. World Economic Forum. The Global Risks Report 2020. Available online: https://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf (accessed on 15 January 2020).
46. Tarazona, J.V.; Martínez, M.; Martínez, M.A.; Anadón, A. Environmental impact assessment of COVID-19 therapeutic solutions. A prospective analysis. *Sci. Total Environ.* **2021**, *778*, 146257. [CrossRef]
47. Liu, K.; Lou, Y. Optimizing COVID-19 vaccination programs during vaccine shortages: A review of mathematical models. *Infect. Dis. Model.* **2022**, *7*, 286–298.
48. Bensaou, M. Portfolios of Buyer–Supplier Relationships. *Sloan Manag. Rev.* **1999**, *40*, 35–44.
49. Lee, D.M.; Drake, P.R. A portfolio model for component purchasing strategy and the case study of two South Korean elevator manufacturers. *Int. J. Prod. Res.* **2010**, *48*, 6651–6682. [CrossRef]
50. Haut-Commissariat au Plan; Système des Nations Unies au Maroc et Banque Mondiale. *Note Stratégique: Impact Social Économique de la Crise du Covid-19 au Maroc*; Nations Unies Maroc: Rabat, Maroc, 2020.
51. Barkia, A.; Laamrani, H.; Belalia, A.; Benmamoun, A.; Khader, Y. Morocco's National Response to the COVID-19 Pandemic: Public Health Challenges and Lessons Learned. *JMIR Public Health Surveill.* **2021**, *7*, e31930. [CrossRef] [PubMed]