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Green Defense Industries in the European Union: The Case of the Battle Dress Uniform for Circular Economy

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Abstract: As climate change is at the top of the world's agenda, the armed forces and other defense actors must give a signal that they are environmentally responsible. In this regard, the defense industry should be one of the first actors to devise new strategies and actions aimed at reducing the environmental footprint. This article focuses on the measures being taken by the defense industry and the armed forces, and on how technology, the circular economy (CE) and Lean principles can contribute to a better environment. A qualitative multimethod research model was used, covering more than one research method, such as a systematic literature review and a case study research. Although the literature highlights that the defense sector in Europe is far from being a green actor, a transition to the CE was identified. In that regard, the European Union (EU) defense industry has been a key player in CE R strategies, such as: repurpose, remanufacture, repair, reuse, reduce and rethink. The contribution of new technologies has empowered military equipment to acquire enhanced characteristics, such as material resistance, while EU technology centers have been instrumental in a green transition. Additionally, more comprehensive research is needed in order to allow generalization of the results.

Keywords: circular economy; climate change; defense industry; environment; lean principles; R strategies; technology

1. Introduction

With the aim of achieving a climate-neutral European Union (EU) by 2050, the quest for energy efficiency, sustainability and environmental protection has progressively increased. The pursuit of green initiatives is particularly important in the European defense industry, as this sector is one of the biggest consumers of public energy in the EU [1–3].

After years of containment, the EU left a significant part of its armed forces with equipment below intended capabilities, i.e., in 2021, none of the EU countries were in the top five of military expenditure [4]. In that regard, only eight European NATO member states have reached the Alliance's target of spending 2% or more of Gross Domestic Product (GDP) on their armed forces by 2021. With the start of the 2022 Russia–Ukraine war, the European Commission (EC) has decided to increase military spending. In line with that decision, Germany has committed to achieving NATO's target of dedicating at least 2% of gross domestic product to defense (1.3% of its GDP in 2021 [4]). However, an increase in military production is likely to make the EU's defense industry one of the less green and sustainable industries, unless key actions are taken.

In mid-2022, the EU announced that it would take steps to invest nearly EUR1.2 billion to support 61 defense–industrial cooperation projects [5]. The European Defense Fund (EDF) is implemented through annual work programs structured in 17 stable thematic and horizontal categories of actions during the period of the Multiannual Financial Framework 2021–2027 [6]. Unsurprisingly, one of the focuses is: "Boosters and enablers for defense to bring a key technology push to the EDF and which are relevant across capability domains, such as [. . .] energy resilience & environmental transition [. . .]" [5, September 2].

Assessing the green economy and circular economy also requires reliable statistical data; in that regard, Stjepanović et al. [6] saw the need to develop alternative models to GDP, such as Green GDP, which provides a clearer perspective on the consequences of economic progress, offering a new approach to quantifying the cost of ecological and environmental degradation [6]. Taking a closer look at the Global Green Economy Index [7] and at the Green Growth Index [8], it is quite easy to find robust statistics associated with the green economy, and in particular our case study. According to the report by the Goldschmeding Foundation [7,9], the citizens of Europe consume an average of 26 kilos of clothes per year, and in 2019, the estimated turnover of the European textiles and clothing (TC) value chain amounted to EUR162 billion. This means that the textile industry has grown by around 3% (2.7% in 2019) in the last ten years. Added to the population growth, the textile industry is an excellent business area to investigate within the scope of the circular economy, which justifies the selection of our case. Although one of the focuses of this research is on environmental issues, it is necessary to stress that there is a general consensus that the dimensions of sustainable development have two more pillars—economic and social. According to Kuhlman and Farrington [10], the 'profit' pillar is seen as the value made by the entire country, expressed as GDP. This, then, is the economic dimension, and the social dimension ('people') concerns human aspirations: equity (translated as income distribution); inclusion (commonly operationalized as employment); and health (expressed by an indicator such as life expectancy or access to medical services). Vallance et al. [11] goes further, defining social sustainability in a triple framework, comprising: (a) basic needs, creation of social capital, justice and so on (known as "development sustainability"); (b) the respect for changes in behavior to achieve biophysical environmental goals (known as "bridge sustainability"); and (c) the preservation of sociocultural characteristics in the face of change, and the ways in which people actively embrace or resist these changes (known as "maintenance sustainability").

In the academic field, few researchers have addressed the green defense industries. Some relevant examples can be found in some chapters of the book entitled *Innovative Technologies and Renewed Policies for Achieving a Greener Defence* [12–15]. From this book, we highlight four chapters. First, Wigell and Hakala [12] developed an introduction to greener defense. The authors argued that this issue should have a twofold approach: (1) as climate change advances, defense actors will increasingly need to understand how their strategy and operational conduct may be affected; and (2) the defense sector will also need to devise new policies and actions aimed at reducing its environmental footprint. Second, Barberini [13] stressed that NATO, during its 2021 Brussels summit, stated that it intends to become the leading organization in understanding and mitigating the security implications of climate change. This showed that the climate issue clearly transcends the borders of the EU. Third, for Nugee [14], defense needs to understand the implications of climate change, adapting equipment and understanding the need to reduce emissions and become more sustainable. In this regard, defense must adopt a green approach, understand the effects of climate change and the technology that is being developed to adapt and mitigate its effects, becoming more self-sufficient and resilient. Fourth, Massa [15] tries to understand how the defense industry can contribute to the green transition. In this regard, the author identifies five direct means of contribution: (1) develop and implement new sustainable technologies and capabilities, contributing to the green transition; (2) invest in technological innovations to enhance the green transition; (3) reduce the industry's own carbon emissions (First-to-Last-Mile); (4) manage energy consumption and transition to more sustainable energy resources; and (5) the defense industry should assume the role of enabling the green transition in support of the Armed Forces. From the similar studies presented above, a nexus is visible between the implementation of new technologies and environmental sustainability for the green transition of the defense industry. Thus, this relationship (i.e., technology and environment) will also be one of the focuses of our article, which is in line with the existing literature.

Despite the recent and very relevant contributions presented in the literature [12–15], to the best of our knowledge there is still no empirical model for a European Green Defense Industry. To fill this gap in the literature, we present the following research question: How to properly carry out a green transition of the EU defense industry? This research question aims to lay the foundations for how technology and the circular economy have aided the green transition in the European defense industry. Preliminary results show that the circular economy is of paramount importance within the defense industry, contrasting with the lack of discussion in the literature. We also highlight the relationship between technology and the environment, as the development of technological solutions has enabled leaner strategies with less use of resources and energy.

The next section of this article describes the research methods, highlighting the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) protocol [16,17] and the CASP (Critical Appraisal Skills Programme) (https://casp-uk.net, accessed on 3 September 2022) [18,19]. Section 3 presents the results of the analysis, including the state of the art, supported by CASP (Table S1) and a synthesis report (Synth Rep) (Table S2). The last section presents the conclusions, synthesizing the theoretical and managerial contributions.

2. Materials and Methods

This article follows a qualitative multimethod research. This option is justified by the need to investigate a contemporary phenomenon within its real-world context [20]. This research strategy encompasses the generation of rich knowledge through the use of two or more scientific methods. The methodological choice was drawn upon the existing level of academic agreement that this type of research: (1) is more powerful when compared to single methods [21]; and (2) combines unique advantages of corroboration and complementarity, allowing one method to support, improve and elaborate on the results of the other method [22]. The selected option deviates from quantitative methods that generally aim to combine or test theories or hypotheses [23,24]. Building on these arguments, Table 1 provides an overview of the methods used in this research, namely the relationship between methods; furthermore, the design of a conceptual model (SLR) and its empirical validation (case study) also evidence the complementarity between methods.

Table 1. Multimethod approach design (adapted from Reis et al. [23]).

Method	Sub-Method(s)	Source(s) of Data Collection	Method Description	Relationship Between Methods
Systematic Literature Review (qualitative)	PRISMA Synth Rep CASP & SJR	Elsevier´ Scopus	Identify, evaluate and synthesize the existing literature	Provides the opportunity to learn about the main theories, concepts, ideas and debates about green defense industries. This method generated theoretical insights for the next phase.
Case study research (qualitative)	Case study research (incl. Protocols)	Interviews, official documents and direct observations	Investigate the phenomenon in its real-world setting with rich contextual data (e.g., interviews) to generate new insights.	This method empirically validates the theoretical insights and build upon these new contributions to theory and practice.

The first method is a systematic literature review (SLR) that will be supported by the PRISMA protocol, a synthesis report (SR), the CASP programme and Scimago Journal Rank (SJR) (https://www.scimagojr.com, accessed on 29 August 2022) [25,26]. Data collection was carried out through the database Elsevier´s Scopus database (https://www.scopus.com, accessed on 27 August 2022) [27]. This method aimed to identify, evaluate and synthesize the existing literature related to the topic. On the other hand, it also offered the opportunity to find the main theories, concepts, ideas and debates about the green defense industry.

The second method is a case study that allowed us to investigate the phenomenon and empirically validate the model. To do so, it used several sources of data collection, such as semi-structured interviews, official documents and direct observation. The next subsections present the methods used in more detail.

2.1. Systematic Literature Review

The search was carried out in Elsevier´s Scopus database, with article title, abstract and keywords (TITLE-ABS-KEY) to identify peer-reviewed journal articles in English. The search terms were TITLE-ABS-KEY "environment" OR "ecosystem" OR "climate" AND "defense industry". Usually, SLRs employ more than one database [28]. However, we only used a single database since the objective was to achieve more objectively the characteristics of SLRs, which are: transparency, replicability and ease of access [29]. Scopus was selected as the largest international and multidisciplinary research database of peer-reviewed manuscripts [27]. An additional argument that justifies the use of Scopus is the coverage of journals in the area of Natural Sciences and Engineering [30,31], areas typically associated with the defense industry. To refine our research, we used the PRISMA protocol. Thus, in August 2022, Scopus yielded 349 manuscripts (Figure 1). We only included manuscripts in English, for reasons of textual comprehension and interpretation and journal articles for quality reasons (n = 128). Additionally, we only included articles from non-technical areas, namely: social sciences; business, management and accounting; environmental sciences; arts and humanities; earth and planetary science; multidisciplinary; economics, econometrics and finance. Once the process was concluded, 92 scientific articles were obtained. In the eligibility phase, all article abstracts were read carefully to exclude articles for which we did not have access to the full text (n = 8), technical articles (n = 7) and articles that had no specific relationship with the topic (n = 49). As no articles other than those from the Scopus search were included, we ended up with the approval of 28 articles for review (Table S3).

The SLRs are known to present several limitations: first, SLRs are known to present a snapshot of a period of time; therefore, relevant articles that are published thereafter will be naturally left out; second, due to a series of screening filters it is likely that some relevant studies were also not considered for the analysis; third, this research is also limited due to the purely theoretical nature of the results, requiring empirical validation [31].

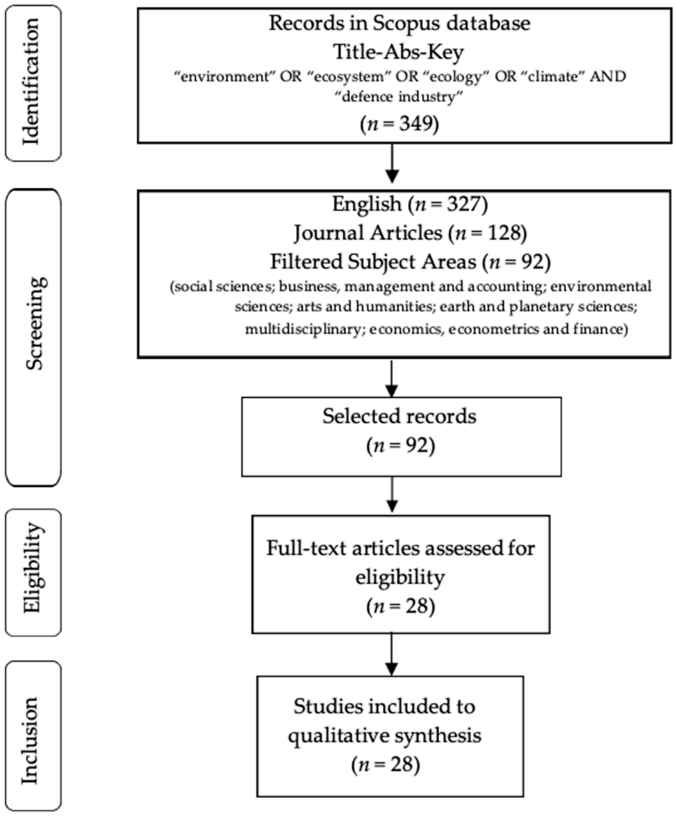

Figure 1. PRISMA protocol.

2.2. Case Study Research

Since the SLR provided theoretical support, enabling a deep and holistic understanding of the phenomenon, the case study consisted of investigating it in its natural environment [20]. To this end, we used multiple sources of data collection, including interviews, document analysis and direct observations. The purpose of using multiple data collection sources was to ensure triangulation and corroboration [32], not depending exclusively on a single source.

The research focused on the Battle Dress Uniform (BDU) case and the unit of analysis was the EU armed forces, represented by three subunits. The main subunit was the Portuguese armed forces, supported by the German and Dutch armed forces. The Portuguese armed forces were selected due to convenience sampling, which is a type of non-probability sampling that is characterized by privileged access to respondents [33]; the German and Dutch armed forces were selected to allow a European comparison. These latter respondents were chosen by snowball sampling. The snowball technique is one of the most popular sampling methods in qualitative research, focusing on the network of contacts and where one respondent suggests another [34]. Although the study included a limited number of respondents (seven Portuguese army officers; five German army officers; four Dutch navy/army officers) we interviewed highly knowledgeable informants, who were able to see the phenomenon from different perspectives. That is, the respondents were chosen according to the different functional areas and different levels of responsibility within the units of analysis. The interviews lasted approximately 45 to 60 minutes and were transcribed verbatim. The research was conducted under the Declaration of Helsinki; thus, all of the respondents gave their permission and signed an informed consent form before participation in the study. Informal interviews were also carried out, usually collected during field observation. Thus, informal conversations served to clarify data from the interviews. Additionally, a specific protocol was developed and the data were recorded in a field diary. Organizational documents were collected essentially from open sources (e.g., official website of units of analysis). In the same way as the direct observation, the official documents allowed the triangulation and corroboration of the data obtained in the interviews. Finally, the case studies have limitations that deserve to be mentioned: first, this article does not have the perspective of generalization. That is, the results that comprise this case may not apply in another region outside the European context. This limitation can be overcome with more comprehensive quantitative studies; second, case studies are known to be time consuming, so we will continue this research endeavor to deepen some of the knowledge gained in this article.

2.3. Data Extraction, Synthesis and Analysis

As mentioned earlier, data were extracted from various collection sources (e.g., Elsevier´s Scopus database, Interviews). Data were also synthesized, using dedicated reports, programs and protocols, and analyzed by a computer-assisted (or aided) qualitative data analysis software (CAQDAS).

Regarding the synthesis phase, a report was prepared to synthesize the existing knowledge, in order to provide a holistic view of the existing literature. This report included: author(s); year; research question(s); gap(s); method(s); source(s) of data collection data; main finding(s); suggestion(s) for future research (Table S2). Data were then assessed using the CASP, which is a qualitative checklist. The programme is available on the website (https://casp-uk.net, accessed on 2 September 2022) [18] and presents all of the information necessary to assess the 28 selected articles. In practical terms, CASP examines the selected articles using 10 possible items (Table S1). CASP was a valuable programme to select high-scoring articles and identify the most relevant topics for analysis. The CASP included a secondary layer, by using SJR, which is an internationally recognized platform that identifies the quality standard (quartile) of a journal. Moreover, for the case study, qualitative interview protocols were prepared. The protocols were developed in two formats (i.e. informal conversational and open-ended interviews) in order to obtain dense and rich data [35], allowing the researcher to synthesize and organize the data.

The analytical phase consisted of processing a significant amount of data (i.e., 3246 pages). To do so, we used content analysis, which is a technique widely known in the social sciences [36] and which enabled a systematic and objective analysis of the phenomenon [37]. The analysis included a CAQDAS [38] using NVIVO 12 (https://www.qsrinternational.com, accessed on 2 September 2022) [39]. This CAQDAS made it possible to integrate, encode and analyze the large volume of data. Once the data were added to the NVIVO 12, the process began with coding the most relevant words and phrases. The coding scheme used the research questions and the SLR as a reference. We then identified the patterns and ideas emerging in the codes, grouping the codes into categories and subcategories. Finally, we looked for patterns by relating codes and categories that were associated to the research question, generating a matrix that provided a more detailed overview of the data.

3. Results and Discussion

The results focus on the theoretical contributions generated by the SRL, and the content analysis assisted in the design of a conceptual framework. The case study empirically validated the theoretical insights, which resulted in a new model that suitable for the defense industry.

3.1. Conceptual Framework

From the CASP analysis, 43% of the articles published were Scopus Q1, while the average CASP score was 17 pts (Table S1), which means that the overall quality was good (on a four-level scale: excellent, good, moderate and poor). Only 18% of the articles scored as excellent [2,40–43], while 61% scored as good and 21% were of moderate quality. The excellent articles focused mainly on topics such as open innovation [40], adaptation to climate change [41], reducing the environmental footprint [2], improving technological development in relation to the environment [42] and transition to green defense [43]. With the lowest score (21%), we found more technical topics related to finance [44], nanotechnology [45] and BAE systems [46]. This phenomenon is explained by the need for holistic environmental studies that encompass industry, governments, universities and society. Based on the above information, we present the conceptual framework for the green defense industry. The conceptual framework was developed with information from the articles that achieved the highest score in the CASP.

The existing literature argues that the defense industry is operating in a triple helix, i.e. universities, governments and industry (Figure 2) [47–49]. Thus, civil society and environment are not found in Figure 2 as the figure is limited to the triple helix. However, the idea that the defense industry begins to operate in the context of a quintuple helix (civil society and environment) is gaining traction among academics. Justifying the previous argument, Reis et al. [40] stressed that the defense industry is moving towards a quintuple helix, where military innovations are being transferred to civil society (dual-use) and with increasing attention to the environment. Despite the efforts, the defense sector in Europe is still far from being a holistic green actor [2]. In this regard, Fiott [2] argues that Europe's armed forces, defense institutions and defense companies exhibit a strong sense of self-interest in greening, embedded in defense market-competition and regulation. In addition to the markets and regulations that make the defense industry greener, new technology has been an increasingly relevant factor in this transition [45]. Ways of greening the defense sector in Europe could include increasing scientific research and following environmental and circular economy policies, as shown in this article further on. To this end, technology parks, universities and companies in the defense sector can also be very relevant, as they develop the necessary and essential technology for a green transition.

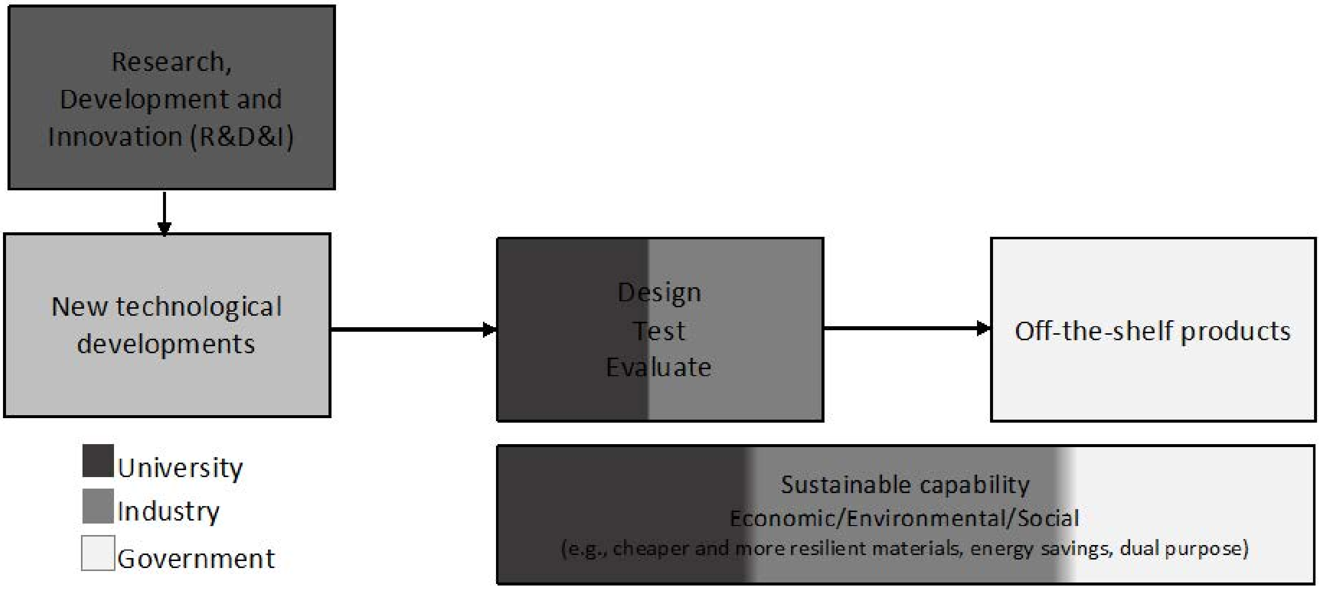

Figure 2. Green defense industries: A conceptual framework.

New technologies are not only critical to supporting traditional industrial and military success, they also play a key role in advancing a sustainable development. Saulters et al. [42] (p. 281) emphasize that the "proactive and holistic approach can facilitate efficient research, design, testing, evaluation, and fielding for novel and off-the-shelf products, thereby assisting developers, end users, and other diverse stakeholders in better understanding tradeoffs in the defense industry and beyond". Some authors go a little further, mentioning that for military organizations the process of organizational greening is a quantum leap, not only technologically, but also mentally [43].

However, the existing literature is somewhat scattered; in general, from the articles analyzed, we identified specific constructs focused on research, development and technological innovation (R&D&I). Technologies coming from the triple helix innovation model—where universities, industry and governments play an active role—are tested and evaluated for use by stakeholders (e.g., the armed forces). The attributes and characteristics of off-the-shelf products are expected to be a guarantee of sustainability and transition to a greener industry. The case study presented in the next sections validated the conceptual model above (Figure 2); however, a new relevant construct was added that had not been previously addressed in the defense industry literature.

3.2. Circular Economy: Going Back to the Literature

The initial interviews made us realize that the concept of the circular economy (CE) was not referred in the SLR. Interestingly, a quick search on Elsevier´s Scopus database with the "defense industry" and "circular economy" in title-abs-key found no matches. We also learned that, in 2016, the European Commission (EC) presented a plan (European Defense Action Plan (EDAP)) that incorporates the circular economy principles for the defense sector [3]. Due to the empirical centrality of the CE and the EC willingness to integrate CE models into the defense sector, we decided to return to the literature to address this need.

CE is seen as "an economic system that replaces the "end-of-life" concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes" [50] (p. 224). Morseletto [51] systematically examined the objectives that make a transition to the CE possible. In this regard, the author presented a framework based on nine comprehensive and common CE strategies (the R strategies) i.e., recover (R9), recycle (R8), repurpose (R7), remanufacture (R6), refurbish (R5), repair (R4), reuse (R3), reduce (R2), rethink (R1) and refuse (R0) that will be covered in this article. Most of the goals presented in Morseletto´s research are related to waste management and resource conservation (R9 and R8). However, these strategies do not necessarily promote a CE because they do not help products to remain in the economy. On the other hand, the R0–R7 strategies are the most powerful and for that reason we will focus our attention on them. Potting et al. [52] presented three target groups, namely: useful application of materials; extend lifespan of products and its parts; and smarter product use and manufacture. Each of these groups presents a sequence of R-strategies with individual definitions (Table 2).

Table 2. CE strategies (adapted from Potting et al. [52]).

Target	ID	R Strategy	Definition
Target 3: Smarter product use and manufacture	R0	Refuse	The product abandons its function or offers the same function with a radically different product.
	R1	Rethink	Make the use of the product more intensive. It may involve reworking ideas and concepts, uses and post-uses of a product.
	R2	Reduce	Increase efficiency in manufacturing (e.g., energy) or use of products consuming fewer natural resources.
Target 2: Extend lifespan of product and its parts	R3	Reuse	Defined as second use (by another owner) of a product that is still in good condition and can fulfill its original function.
	R4	Repair	Repair and maintenance of a defective or used product so that it can be used for its original function.
	R5	Refurbish	Restore an old product and update it.
	R6	Remanufacture	Use of parts of the discarded product in a new product with the same function.
	R7	Repurpose	Repurpose or decontextualizing is the use of discarded products or their part in a new product with different function.
Target 1: Useful application of materials	R8	Recycle	Extraction of materials from discarded products to obtain the same (high grade) or inferior (low grade) quality.
	R9	Recover	Recovery as material incineration with energy recovery. Refers to waste that is not recycled but is used as an energy source.

The circularity of the R strategies increases proportionately from the incineration of materials with energy recovery to the radical abandonment of redundant products for waste [53]. The first target includes a set of strategies R8–R9, which refers to solid waste that are destined for landfills or burning for heat recovery. From the processing of these strategies, energy (R9) or materials (R8) are obtained, although the energy conversion efficiency rates are relatively low and their processing is expensive. However, as argued by Ghisellini et al. [54], it is on these strategies that most CE policies focus. The second group focuses on R3–R7 strategies with the objective of retaining finished materials and their parts in the economy for a longer period, maintaining or improving their value. For this group to last, it is necessary to have a well-built process, such as reverse logistics and profitable returns for all stakeholders. Note that this process should not prevent progressive innovation and its incorporation or replacement by alternative products or products that have higher standards (e.g. more energy efficient, safer, more resilient/resistant). To achieve greater circularity with less consumption of resources, prolonging the useful life of products through reuse, refurbishment and remanufacturing is advantageous as it preserves the usefulness and value of the products [53]. The use and manufacture of smarter products (third group) encompasses three R0–R2 strategies, known to be precursory, enabling and transformative [51]. Within the scope of these strategies, CE occurs even before the start of production (ex ante), being closely linked to the manufacturing projects. This is in line with the very definition of CE, which is discussed in the published literature with roots in regenerative design. In that regard, the British Standard Institution defines the circular economy as an "economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguish between technical and biological cycles" [55] (p. 10) where the restorative/regenerative function of circular economy is pointed out as preventing value loss [56].

3.3. Green Defense Industry: An Empirical Framework

Starting with the Portuguese defense industry, idD–Portugal is the entity responsible for implementing a strategy for the national and international promotion of the Portuguese Defense Technological and Industrial Base (DTIB) [57]. Its action focuses on the relationship between the Portuguese Armed Forces, private companies, universities and research centers, and the international organizations of which Portugal is a member [58].

As the Portuguese DTIB is highly segmented (+20 segments) and with a representation of more than 380 organizations, the Portuguese Ministry of Defense decided to create a consortium called "AuxDefense". At the same time, high-level defense projects were developed in parallel, such as the ACU (Advanced Combat Uniform) and SCS (Soldier´s Combat System) leaded by CITEVE (Technological Center for Textile and Clothing Industries).

The AuxDefense consortium and ACU/SCS projects are operated within the scope of the triple helix, bringing together the Portuguese Armed Forces (Army and Air Force), Universities (e.g., University of Minho), Technological Platforms (e.g., Fibrenamics) and Centers (e.g., CITEVE), as well as several private companies (e.g., LMA–textiles). The most relevant projects within the scope of our case study were led by CITEVE. This technological center developed multilayer textiles with innovative auxetic structures, using fibrous materials and advanced structure with high mechanical properties used in the manufacture of clothing components aiming at high performance. The developed BDUs had as their main features anti-cut protection, breathability, antimicrobial and high resistance, being currently used by the Portuguese Armed Forces in national territories and abroad. Before being produced on a large scale for the Portuguese Army, under the qualification system for military systems or equipment, the BDUs received the Army Tested/Combat Proven certificate. Therefore, this evidence is in line with the test and evaluation construct of the conceptual theoretical model (Figure 2).

The above advanced defense materials are giving signs that defense industries are becoming environmentally responsible; becoming relevant actors, as they design R strategies and actions aimed at reducing the environmental footprint. Sustainability also incorporates the social and economic dimensions. Starting with the last one, and as we will see further on in this section, the reuse of materials has allowed the Netherlands to make very significant annual savings; in relation to the social issue, the dual use of military materials is fundamental for the scope of innovation and the improvement of citizens' quality of life. According to Portuguese respondents, the BDUs used by the Portuguese armed forces are on the path to a circular defense economy. The argument falls within the scope of the R strategy for repurposing (R7), remanufacturing (R6), repairing (R4), reusing (R3), reducing (R2) and rethinking (R1).

At the level of target one (Table 2) no case-associated R8–R9 strategies (BDU) were observed. This result is original, as it is on these two strategies that most CE policies focus.

Target two involves extending the lifespan of defense products and its parts. In this section, we found three strategies out of five. Within the scope of R7, Portuguese respondents argued about the reuse of camouflage on some occasions. As an example, the interviewees highlighted the use of the product with a different function from the original. In other words, Portuguese special operations forces have a tradition of using old BDUs to craft their Ghillie sniper suit. This is an interesting situation that clearly demonstrates that BDUs are reused for training/operational missions. At a time when the demand for sustainability-oriented projects is high, the use of lean principles and the simultaneous creation of value has become increasingly important. Within the European Green Agreement (EDAP), the Dutch government uses R6 to reuse discarded BDU parts (reducing waste) and to incorporate these features into new products with the same function, creating value with fewer resources. Thus, this remarkable example of R6 from the Dutch Ministry of Defense is based on the collection of old uniforms and equipment, being used in the manufacture of new BDUs. This practice has several advantages, as it avoids misuse by third parties (if they are discarded or sold) and avoids incineration, unnecessary expenses and highly polluting activities. According to the European Defense Agency (EDA), the destruction of materials in the Netherlands cost the Ministry of Defense (MoD) EUR500,000 a year to destroy materials that still had reuse value [59]. The EDA also mentioned that in 2017, the government's central purchasing entity for clothing and personal equipment (KPU) began to apply CE principles. Therefore, KPU managed to extract reusable materials and prolong the useful life of various items, now generating additional annual revenue from EUR750,000 for the Ministry, while saving 14,500 tons of CO_2 each year. In addition to existing revenues, there are also various funding opportunities. For instance, the new Incubation Forum for the Circular Economy in European Defense (IF CEED) generates CE opportunities and policies in the European defense domain through various transnational projects [60]. IF CEED Projects aim to improve the environmental sustainability of the defense sector and contribute to the EU Green Deal. The IF CEED lasts for two years and is managed by the EDA with a financial contribution of EUR784,000 from the European Commission (LIFE programme) and the Luxembourg Defense Directorate [60]. With regard to R4, when the Portuguese armed forces are assigned to carry out missions abroad, they receive a repair kit, so that they can individually restore the original characteristics of their BDUs. In contrast, German military personnel returning from missions abroad must return their BDUs to be repaired, disinfected and reused (R3). This situation is not the case for the Portuguese military, who continue to use their own BDUs. In addition, during the interviews we also realized that the donation of defense materials is also a common practice. For instance, the Portuguese BDUs are occasionally donated to the Community of Portuguese-Speaking Countries and/or other partner states.

Lastly, target three requires making smarter products. In this regard, it identified two of the three possible strategies. As of R2, the use of a more resistant and durable BDUs allows the consumption of less resources, as it is necessary to manufacture less textile materials and therefore consume, e.g., less energy and materials. This is in line with Massa [15], who stressed the need to manage energy consumption and transition to more sustainable energy resources. R1 followed, in this regard, the defense industry has taken significant steps in Portugal. The interviews, corroborated with official documents [61,62], showed the occurrence of projects that allowed the development of solutions that integrate differentiated materials. For example, the VESTLIFE project aims to develop a new lightweight and modular bulletproof integral solution that incorporates a chemical, biological, radiological and nuclear (CBRN) detection system [62]. This protection system will consist of different levels, mainly light and hard armor. The difficulty lies in finding a balanced architecture of materials that allows for comfort and protection at the same time. Thus, rethinking is associated with the development of new ideas and concepts that enable the integration of advanced solutions and provides new technological capabilities to BDUs, avoiding the creation of additional equipment. Another example is the STRESSENSE project, which aims to develop sensors/biosensors for the detection and continuous monitoring of biochemical markers of physical and emotional stress in textiles/clothing.

Having identified six R strategies out of nine possible ones, we argue that the defense industry is on track for a successful green transition. What we mean by that is that there is the possibility of deepening CE activities and analyzing the possibilities of encompassing R5 and R0 strategies in the defense industry. The empirical framework (Figure 3) supports the idea that the European defense industry is operating on a triple helix. However, the conceptual framework has changed, with the incorporation of the circular economy construct, while the defense industry transitions to the green domain. This raises the question of whether the defense industry is heading towards a quintuple helix as there is increasing attention paid to the environment. This argument is also evident in the European Defense Action Plan (EDAP), namely with regard to the need for greater use of energy efficiency measures and renewable energies in the EU armed forces. Therefore, it seems evident that the armed forces, defense institutions and defense companies in Europe are starting to show an increasingly strong interest in the environmental domain, inserted in the competition and regulation of the defense market, as argued by Fiott [2].

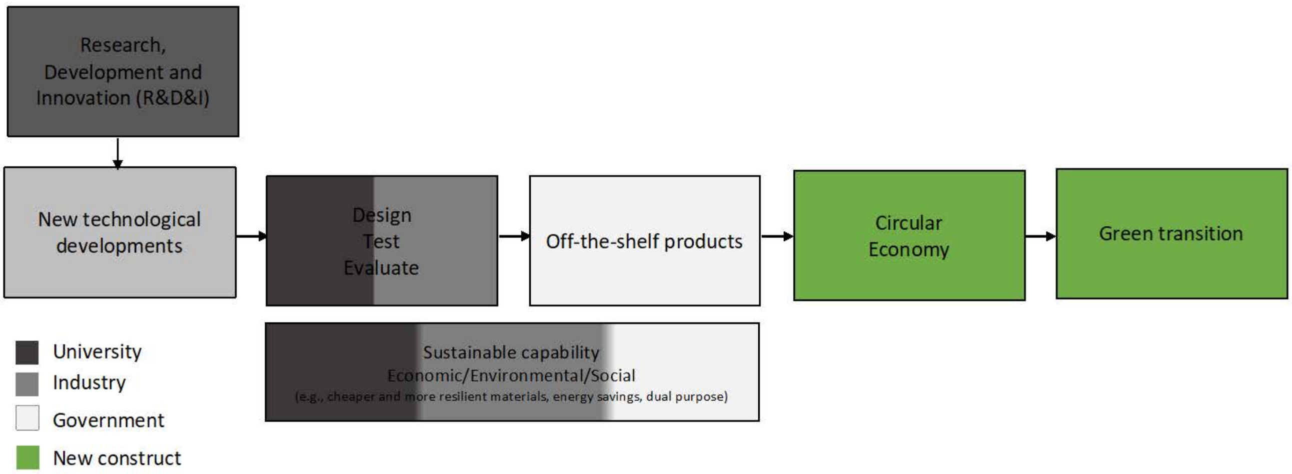

Figure 3. Green defense industries in the EU: An empirical framework.

4. Conclusions

We draw the conclusions into contributions to theory, that is, what this article adds to the existing literature, and managerial contributions, as we identify the most relevant issues for practitioners working in the defense industry or armed forces. Finally, we propose some brief paths for future research.

4.1. Theoretical and Managerial Contributions

This article brings new contributions to theory. First, the relevance of CE in the defense industry is evident, in contrast to the lack of theoretical discussion in this regard. In addition, we found several articles discussing the importance of the triple helix [47–49], however, this article introduces new evidence that justifies further research to verify whether the EU defense industry operates within the framework of a quintuple helix. Thus, the focus of this article is on the presentation of "technology" and the "circular economy" as possible helices. In this regard, we are taking small steps and being very cautious in our arguments, as there is still no clear evidence in the literature that the defense industry operates within a quintuple helix, which is the combination of a triple helix, technology and the environment (via the circular economy). Second, this article argues that no R8–R9 strategy is associated with the case. According to Ghisellini et al. [54] it is the R8–R9 strategies that most CE policies focus on, even though the efficiency rates of these strategies are relatively low. This article is original in that it argues that CE policies in the EU defense industry focus on higher targets, which are focused on extending the lifespan of defense products and its parts, as well as to use and manufacture smarter defense products. In this regard, design and re-design replaces the concept of "end of life" with restoration and regeneration, aiming at the elimination of waste through superior design of materials, products, systems and, within that, business models [50]. Third, this article identifies a number of pieces of scientific evidence linking technology and the environment. For example, in target three (i.e., smarter product use and manufacture) we highlighted the use of technologies to develop more resistant and durable defense materials, enabling lean strategies with a lower use of resources and energy. An additional example shows the existence of projects that aim to develop technological solutions that integrate several attributes in a single defense product. These projects therefore allow for a reduction in creating additional equipment, making the defense industry more efficient and affordable. In short, answering the research question, the green transition of the EU defense industry should be ensured by following the empirical framework and the fulfillment of the identified R strategies (i.e., currently six out of nine strategies).

We also present three managerial contributions. First, this article suggests increasing discussion among the EU member states to fulfill the circular economy targets in the EU armed forces. Thus, it may be important to align strategies and to develop benchmarking activities among EU member states. As an example, we found that German military personnel returning from missions abroad must return their BDUs to be reused (R3); however, this good practice has not yet been fully adopted by the Portuguese military forces. Second, it is necessary to reconcile circular economy and lean principles in the context of the defense industry, in order to create customer-oriented solutions that minimize resource consumption and improve added value for the end user. In other words, the greater the adoption of the lean principles in the economy, the greener the EU defense industry will be [63]. Finally, technology centers such as CITEVE have been central to the development of a smart factory vision in the defense industry, developing highly technological apparel models such as the VESTLIFE and STRESSENSE projects. This is in line with the recommendations of Massa [15], where the defense industry and smart factories should assume the role of enabling the green transition in support of the armed forces. Therefore, it is relevant that DTIB managers from the various EU member states understand the importance that smart factories such as CITEVE bring to the modernization of the EU defense industry and the military.

4.2. Future Research Avenues

Comprehensive research with multiple cases (i.e., defense materials) and subunits of analysis (EU armed forces) are needed to deepen knowledge and allow generalization. Research of this nature must be developed using EU defense-funding and should include a quintuple helix: universities–industry–governments (triple helix), –technology (quadruple helix) and –environment (quintuple helix). Comprehensive research can also be useful for designing a roadmap for CE in EU defense, as in the notable article by Soufani et al. [64], who focused on the CE roadmap, in this case for the Dutch defense industry. An additional option could be the development of a specific conceptual framework for the CE in the defense industry. The purpose of this research can be twofold: first, to develop

CE opportunities to encompass the 9Rs; second, develop more options to reinforce the existing 6Rs.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su142013018/s1, Table S1: Methodological quality ratings based on CASP (Critical Appraisal Skills Programme); Table S2: Synthesis report (n = 28); Table S3: General information of selected articles.

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References

1. EDA. Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS). Available online: https://eda.europa.eu/docs/default-source/events/eden/phase-i/final-report/consultation-forum-for-sustainable-energy-in-the-defence-and-security-sector---final-report.pdf (accessed on 4 September 2022).
2. Fiott, D. Reducing the Environmental Bootprint? Competition and Regulation in the Greening of Europe's Defense Sector. *Organ. Environ.* **2014**, *27*, 263–278. [CrossRef]
3. European Commission. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions—European Defence Action Plan. Available online: https://eur-lex.europa.eu/legal-content/en/txt/pdf/?uri=celex:52016dc0950&from=en (accessed on 7 September 2022).
4. Lopes da Silva, D.; Tian, N.; Béraud-Sudreau, L.; Marksteiner, A.; Liang, X. *Trends in World Military Expenditure, 2021*; Stockholm International Peace Research Institute: Stockholm, Sweden, 2022.
5. European Commission. Defence Industry: EU Takes Steps to Invest Almost €1.2 Billion to Support 61 Defence Industrial Cooperation Projects. Available online: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_4595 (accessed on 2 September 2022).
6. Stjepanović, S.; Tomić, D.; Škare, M. A new approach to measuring green GDP: A cross-country analysis. *Entrep. Sustain. Issues* **2017**, *4*, 574–590. [CrossRef]
7. GGEI (Global Green Economy Index). Green Policy Platform. 2018. Available online: https://www.greengrowthknowledge.org/research/2018-global-green-economy-index-ggei (accessed on 24 September 2022).
8. GGGI. Green Growth Index: Concepts, Methods and Applications. *GGGI Technical Report, Nº 5, Global Green Growth Institute.* Available online: https://greengrowthindex.gggi.org/wp-content/uploads/2019/12/Green-Growth-Index-Technical-Report_20191213.pdf (accessed on 24 September 2022).
9. Carrone, N.; Lagunes, L.; Duijn, H.; Wilting, J.; Novak, M.; Metta, J.; Goesaert, T.; Bachus, K. Putting Circular Textiles to Work: The employment potential of circular clothing in the Netherlands. Goldschmeding Foundation. Available online: https://assets.website-files.com/5d26d80e8836af2d12ed1269/60d484479ef55512ac50d615_20210624%20-%20CJI%20Tex%20skills%20-%20paper%20-%20297x210mm.pdf (accessed on 23 September 2022).
10. Kuhlman, T.; Farrington, J. What is sustainability? *Sustainability* **2010**, *2*, 3436–3448. [CrossRef]
11. Vallance, S.; Perkins, H.; Dixon, J. What is social sustainability? A clarification of concepts. *Geoforum* **2011**, *42*, 342–348. [CrossRef]
12. Wigell, M.; Hakala, E. Towards a Greener Defence: An Introduction. In *Innovative Technologies and Renewed Policies for Achieving a Greener Defence*; Iacovino, G., Wigell, M., Eds.; NATO Science for Peace and Security Series C: Environmental Security; Springer: Dordrecht, The Netherlands, 2022; pp. 1–6. ISBN 978-94-024-2185-9.
13. Barberini, P. NATO Green Defence: From the 2014 Green Defence Framework to the 2021 Climate Change and Security Action Plan. In *Innovative Technologies and Renewed Policies for Achieving a Greener Defence*; Iacovino, G., Wigell, M., Eds.; NATO Science for Peace and Security Series C: Environmental Security; Springer: Dordrecht, The Netherlands, 2022; pp. 7–16. ISBN 978-94-024-2185-9.

14. Nugee, R. The Operational Advantages of a Greener Defence: What Should Defence Be Prepared for in the Next 20–30 Years as a Result of Climate Change? In *Innovative Technologies and Renewed Policies for Achieving a Greener Defence*; Iacovino, G., Wigell, M., Eds.; NATO Science for Peace and Security Series C: Environmental Security; Springer: Dordrecht, The Netherlands, 2022; pp. 17–33. ISBN 978-94-024-2185-9.
15. Massa, T. The Possible Contribution of the Defence Industry to the Green Transition. In *Innovative Technologies and Renewed Policies for Achieving a Greener Defence*; Iacovino, G., Wigell, M., Eds.; NATO Science for Peace and Security Series C: Environmental Security; Springer: Dordrecht, The Netherlands, 2022; pp. 85–94. ISBN 978-94-024-2185-9.
16. Moher, D. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Ann. Intern. Med.* **2009**, *151*, 264. [CrossRef] [PubMed]
17. PRISMA-P Group; Moher, D.; Shamseer, L.; Clarke, M.; Ghersi, D.; Liberati, A.; Petticrew, M.; Shekelle, P.; Stewart, L.A. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 Statement. *Syst. Rev.* **2015**, *4*, 1. [CrossRef]
18. CASP (Critical Appraisal Skills Programme). Available online: https://casp-uk.net (accessed on 3 September 2022).
19. Singh, J. Critical Appraisal Skills Programme. *J. Pharmacol. Pharmacother.* **2013**, *4*, 76–77. [CrossRef]
20. Yin, R. *Case Study Research and Applications: Design and Methods*, 6th ed.; SAGE: Los Angeles, CA, USA, 2018; ISBN 978-1-5063-3616-9.
21. Seawright, J. *Multi-Method Social Science: Combining Qualitative and Quantitative Tools*, 1st ed.; Cambridge University Press: Cambridge, UK, 2016; ISBN 978-1-107-09771-1.
22. Reis, J.; Amorim, M.; Melão, N. Multichannel Service Failure and Recovery in a O2O Era: A Qualitative Multi-Method Research in the Banking Services Industry. *Int. J. Prod. Econ.* **2019**, *215*, 24–33. [CrossRef]
23. Morgan, D.L. From Themes to Hypotheses: Following Up with Quantitative Methods. *Qual. Health Res* **2015**, *25*, 789–793. [CrossRef] [PubMed]
24. Brannen, J. *Mixing Methods: Qualitative and Quantitative Research*; Routledge: Abingdon, UK, 2017; ISBN 978-1-351-91718-6.
25. SJR (Scimago Journal Rank). Available online: https://www.scimagojr.com (accessed on 29 August 2022).
26. Falagas, M.E.; Kouranos, V.D.; Arencibia-Jorge, R.; Karageorgopoulos, D.E. Comparison of SCImago Journal Rank Indicator with Journal Impact Factor. *FASEB J.* **2008**, *22*, 2623–2628. [CrossRef] [PubMed]
27. Reis, J. Politics, Power, and Influence: Defense Industries in the Post-Cold War. *Soc. Sci.* **2021**, *10*, 10. [CrossRef]
28. Thomé, A.M.T.; Scavarda, L.F.; Scavarda, A.J. Conducting Systematic Literature Review in Operations Management. *Prod. Plan. Control* **2016**, *27*, 408–420. [CrossRef]
29. Scopus. About Scopus: Abstract and Citation Database—Elsevier. Available online: https://www.elsevier.com/solutions/scopus (accessed on 1 September 2022).
30. Mongeon, P.; Paul-Hus, A. The Journal Coverage of Web of Science and Scopus: A Comparative Analysis. *Scientometrics* **2016**, *106*, 213–228. [CrossRef]
31. Reis, J.; Marques, P.A.; Marques, P.C. Where Are Smart Cities Heading? A Meta-Review and Guidelines for Future Research. *Appl. Sci.* **2022**, *12*, 8328. [CrossRef]
32. Bryman, A. Integrating Quantitative and Qualitative Research: How Is It Done? *Qual. Res.* **2006**, *6*, 97–113. [CrossRef]
33. Etikan, I. Comparison of Convenience Sampling and Purposive Sampling. *AJTAS* **2016**, *5*, 1. [CrossRef]
34. Berndt, A.E. Sampling Methods. *J. Hum. Lact.* **2020**, *36*, 224–226. [CrossRef] [PubMed]
35. Turner, D. Qualitative Interview Design: A Practical Guide for Novice Investigators. *TQR* **2014**, *15*, 1178. [CrossRef]
36. Scott, R.A.; Kosslyn, S.M.; Buchmann, M. *Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource*; Wiley: Hoboken, NJ, USA, 2015; ISBN 978-1-118-90077-2.
37. Reis, J.; Amorim, M.; Melão, N.; Cohen, Y.; Rodrigues, M. Digitalization: A Literature Review and Research Agenda. In *Proceedings on 25th International Joint Conference on Industrial Engineering and Operations Management—IJCIEOM, 15-17 July, Novi Sad, Serbia*; Anisic, Z., Lalic, B., Gracanin, D., Eds.; Lecture Notes on Multidisciplinary Industrial Engineering; Springer International Publishing: Cham, Switzerland, 2020; pp. 443–456. ISBN 978-3-030-43615-5.
38. Edhlund, B.M.; McDougall, A.G. *NVivo 12 Essentials: Your Guide to the World's Most Powerful Data Analysis Software*; Lulu Press: Morrisville, NC, USA, 2019; ISBN 978-1-387-74949-2.
39. NVIVO 12. QSR International – NVIVO software. Available online: https://www.qsrinternational.com (accessed on 2 September 2022).
40. Reis, J.; Melão, N.; Costa, J.; Pernica, B. Defence Industries and Open Innovation: Ways to Increase Military Capabilities of the Portuguese Ground Forces. *Def. Stud.* **2022**, *22*, 354–377. [CrossRef]
41. Garfin, G.; Falk, D.A.; O'Connor, C.D.; Jacobs, K.; Sagarin, R.D.; Haverland, A.C.; Haworth, A.; Baglee, A.; Weiss, J.; Overpeck, J.; et al. A New Mission: Mainstreaming Climate Adaptation in the US Department of Defense. *Clim. Serv.* **2021**, *22*, 100230. [CrossRef]
42. Saulters, O.S. Enhancing Technology Development Through Integrated Environmental Analysis: Toward Sustainable Non-Lethal Military Systems. *Integr. Environ. Assess. Manag.* **2007**, *6*, 281–286. [CrossRef]
43. Sandström, J. Greening the Swedish Defence Material Administration—A Case Study on the Force of Industry in Environmental Policy-Making: Greening The Swedish Defence Material Administration. *Eur. Environ.* **2004**, *14*, 356–367. [CrossRef]
44. Sydorov, O.; Tarasov, S.; Tsybulnyk, N.; Tsybulnyk, T.; Rusetskyi, A. Financial Security Management of Enterprises Operating in the Defense Industry. *J. Secur. Sustain. Issues* **2020**, *9*, 1481–1495. [CrossRef]

45. Ghorshi Nezhad, M.R.; Zolfani, S.H.; Moztarzadeh, F.; Zavadskas, E.K.; Bahrami, M. Planning the Priority of High Tech Industries Based on SWARA-WASPAS Methodology: The Case of the Nanotechnology Industry in Iran. *Econ. Res. Ekon. Istraživanja* **2015**, *28*, 1111–1137. [CrossRef]
46. BAE Systems Takes Environmental Training to the Top: Senior Executives Learn How to Integrate Green Issues into Their Everyday Functions. *Hum. Resour. Manag. Int. Dig.* **2014**, *22*, 7–10. [CrossRef]
47. Fernandes, L.L.; Rosa, G.F.; Araújo, L.O.D.; Júnior, J.L.A. The Triple Helix Approach in the Defence Industry: A Case Study at the Brazilian Army. *World Rev. Sci. Technol. Sustain. Dev.* **2020**, *16*, 22. [CrossRef]
48. Da Silva, M.V.G.; Olavo-Quandt, C. Defense System, Industry and Academy: The Conceptual Model of Innovation of the Brazilian Army. *J. Technol. Manag. Innov.* **2019**, *14*, 53–62. [CrossRef]
49. Jan, T.-S.; Chen, H.-H. Systems Approaches for the Industrial Development of a Developing Country. *Syst. Pract Act. Res.* **2005**, *18*, 365–377. [CrossRef]
50. Kirchherr, J.; Reike, D.; Hekkert, M. Conceptualizing the Circular Economy: An Analysis of 114 Definitions. *Resour. Conserv. Recycl.* **2017**, *127*, 221–232. [CrossRef]
51. Morseletto, P. Targets for a Circular Economy. *Resour. Conserv. Recycl.* **2020**, *153*, 104553. [CrossRef]
52. Potting, J.; Hekkert, M.; Worrell, E.; Hanemaaijer, A. *Circular Economy: Measuring Innovation in the Product Chain*; PBL Netherlands Assessment Agency: Amstedam, The Netherland, 2017; Volume 46.
53. Lei, H.; Li, L.; Yang, W.; Bian, Y.; Li, C. An analytical review on application of life cycle assessment in circular economy for built environment. *J. Build. Eng.* **2021**, *44*, 103374. [CrossRef]
54. Ghisellini, P.; Cialani, C.; Ulgiati, S. A Review on Circular Economy: The Expected Transition to a Balanced Interplay of Environmental and Economic Systems. *J. Clean. Prod.* **2016**, *114*, 11–32. [CrossRef]
55. BSI. BS 8001:2017; *Framework for Implementing the Principles of the Circular Economy in Organizations—Guide*; The British Standards Institution: London, UK, 2017; Available online: https://www.bsigroup.com/en-GB/standards/benefits-of-using-standards/becoming-more-sustainable-with-standards/BS8001-Circular-Economy/ (accessed on 24 September 2022).
56. Pauliuk, S. Critical appraisal of the circular economy standard BS 8001: 2017 and a dashboard of quantitative system indicators for its implementation in organizations. *Resour. Conserv. Recycl.* **2018**, *129*, 81–92. [CrossRef]
57. National Defense. IdD–Platform of National Defense Industries, S.A. Available online: https://www.defesa.gov.pt/pt/defesa/organizacao/see/paginas/default_idd.aspx (accessed on 2 September 2022).
58. idD—Portugal. IdD Portugal Defence. Available online: https://www.iddportugal.pt/en/ (accessed on 2 September 2022).
59. EDA (European Defense Agency). *Circular Economy in Defense: Advancing Circular Economy in Defense.* Available online: https://eda.europa.eu/webzine/issue20/in-the-field/advancing-circular-economy-in-defence (accessed on 23 September 2022).
60. EDA (European Defense Agency). *EDA´s New Forum for Circular Economy in European Defense Underway.* Available online: https://eda.europa.eu/news-and-events/news/2022/01/27/eda-s-new-forum-for-circular-economy (accessed on 23 September 2022).
61. VESTLIFE. Vestlife—Ultralight Modular Bullet Proof Integral Solution. Available online: http://vestlife-project.eu (accessed on 4 September 2022).
62. CITEVE. Vestlife—Ultralight Modular Bullet Proof Integral Solution. Available online: https://www.citeve.pt/artigo/vestlife (accessed on 4 September 2022).
63. Holweg, M. The Genealogy of Lean Production. *J. Oper. Manag.* **2007**, *25*, 420–437. [CrossRef]
64. Soufani, K.; Tse, T.; Esposito, M.; Dimitrou, G.; Kikiras, P. *A Roadmap to Circular Economy in EU Defence Inspired by the Case of the Dutch Ministry of Defence*; The European Financial Review: London, UK, 2018; pp. 55–60.