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Leveraging the Entrepreneurial Method as a Tool for the Circular Economy: The Case of Wood Waste

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Abstract: New global and domestic policy and regulatory initiatives promoting a circular economy have renewed interest in the beneficial repurposing of commercial waste streams. Likewise, consumer trends and customers' increased understanding of what they purchase, where it comes from, and what happens to it post-consumption have forced firms to consider reducing and reusing their production waste streams. The forest products industry is an exemplar of becoming more adept at reorganising and exploiting repurposed waste streams for beneficial reuse. This paper explores three case studies from the Australian forestry sector that illustrate how wood waste is being profitably repurposed as an input into other products. We use the lens of the entrepreneurial method to explore how firms recognise, strategically access, and exploit the sustainable opportunities that can range from sustainably sourced inputs to environmental-, social-, and governance-driven consumption and investments. Effectual logic allows the reconceptualisation of forestry waste streams into inputs for use in creating new commercial products and provides a theoretical framework. While the repurposing of wood waste is profitable for the forestry firm, we found that social and economic gains reach far beyond the region in which these activities occur. Innovations often stimulate other innovations, resulting in a virtuous cycle within regional Australia's emerging circular economy.

Keywords: innovation; forest sustainability; entrepreneurial method; sustainability; circular economy; effectuation



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1. Introduction

Schandl et al. [1] developed a technology and innovation roadmap that can be used to support strategic and long-term planning when identifying opportunities to reduce the environmental and health impacts of waste materials in Australia. This roadmap assists in supporting strategic and long-term planning by linking available and emerging technology solutions with short- and long-term objectives.

Finding the right entrepreneur–environment nexus lies in taking an entrepreneurial perspective in which environmental degradation, which is a global problem, can be re-envisioned as an opportunity for value creation [2].

The reuse of post-production or recycled materials is a modern trend used in many industries, e.g., in the production of chipboard [3], car tyres [4], and plastic [5]. Schandl et al.'s [1] policy roadmap highlights Australia's paper industry, along with plastic, tyre, and glass producers. It articulates imperatives for paper manufacturers to reduce, recycle, and repurpose paper waste to use as input in creating new products and new markets for Australia's emerging circular economy. The objectives of a circular economy require entrepreneurship to develop and exploit new market opportunities [2]. In addition, access

to consumer and financial markets is more dependent on environmental, social, and governance (ESG) policies [6]. Critically, these stakeholder ESGs and reputational concerns extend forward and backward throughout the organisation's value chain [7]. Drawing on Miles et al. [8], ISO 14000 is mentioned to likely emerge as the international environmental management process standard. This will have an extensive impact on all stakeholders, including international buyers and international marketers, where ISO 14000 compliance will be encouraged or demanded by vendors. This surge can lead to suppliers with a less focused environmental strategy being forced to adopt this standard if they want to remain part of the supply chain of large multinational corporations.

Therefore, ESG issues impact a corporation's stakeholders due to the nature of its environmental, social, and governance externalities [9,10]. The externalities resulting from forestry, including climate change impacts, waste disposal, landfill concerns, water/food/fibre security, and CSR governance issues, force firms in the forestry sector to reconsider their relationship with the natural, social, and regulatory environments. The 3M Corporation recognised that commercial waste streams primarily comprise unused production inputs, with the level of pollution from production indicating inefficient and ineffective processes [11]. As a remedy, 3M developed the Pollution, Prevention, Pays initiative [12]. Unfortunately, not all waste streams can be eliminated, resulting in a search for new technologies and business models to beneficially repurpose commercial waste, now referred to as the circular economy [13].

Urbinati et al. [14] noted that a circular economy has a process that includes reducing, repurposing, remanufacturing, and recycling, which is quite similar to the 3M philosophy. Early work in the circular economy often focused on the forest and wood products industry [15,16], for example, new technologies such as Licella's Cat-HTR™ (<https://www.licella.com/news/>) (accessed on 16 December 2021) process, which reprocesses forest and wood waste streams into biocrude that can be refined into fuels and chemicals. However, like the challenge 3M faced decades ago, organisations attempting to engage as an actor in the circular economy must consider how they can remanufacture unavoidable waste streams into commercially viable products for existing or new markets [8,17,18].

Reducing the amount of post-production waste can be achieved by reducing the size of wood considered as waste in production processes, size reduction downcycling of waste wood [19], or introducing new algorithms to assist in better placement of the wood cutting lines [20].

The Australian Forest Products Association estimated that in 2021 about 120,000 people would work directly in forestry or related manufacturing (<https://ausfpa.com.au/quick-facts/>) (accessed on 16 December 2021). These operations also tend to create jobs in regional areas, often with low opportunities for other forms of employment. We focus on how these activities lead to the creation of markets sustainably in terms of economic, social, community, and political leverage.

2. The Entrepreneurial Method

The linear, scientific view that espouses causal thinking to identify, evaluate, and exploit opportunities does not reflect the actions of successful serial entrepreneurs [21,22]. Entrepreneurs tend to use a more entrepreneurial method [23] based on effectual logic to create, assess, and exploit commercial and social problems. Effectuation logic considers waste and climate change problems as potential commercial opportunities that can be iteratively solved by a process that starts with the entrepreneur's values and capabilities and leverages these to create partnerships used to exploit the opportunity. Sarasvathy [23,24] found that effectuation consists of four processes: (1) self and organisational awareness of values, resources, and capabilities; (2) only incurring affordable losses by leveraging customers, investors, and suppliers to reduce risks; (3) exploiting contingencies and serendipity as a source of opportunities; and (4) integrating the resources of partners and contacts to benefit all. The entrepreneurial method's philosophy of using effectuation to solve social problems fits into a circular economy by effectually leveraging waste stream resources to create more

incremental value for society from commercial waste through employment opportunities, sale of waste-based products, and a reduction in burning or burying waste.

We use the Australian forest industry case studies to illustrate how these enterprises leverage harvest residues by developing a sustainable entrepreneurial initiative. We found that the potential social and economic gains reach far beyond the region where these entrepreneurial activities occur. Innovations often stimulate the development of other innovations [25], potentially resulting in a virtuous cycle of environmental innovations within Australia's circular economy [1]. To accomplish this requires the Australian forestry sector to follow the lead of Australian agriculture and fully embrace entrepreneurship as a necessary capability for its survival (e.g., [26]).

Forestry entrepreneurship is becoming a more accepted set of processes within the forestry industry. The entrepreneurial method may create economic options to sustainably manage the "natural environmental, social and economic dimension" [27]. Mourao and Martinho [28] described how forest entrepreneurship initiatives emerged to address diverse problems faced in forestry in meeting the expectations of many stakeholders, including firms, NGOs, government, communities, and individuals. Forest industries then acted entrepreneurially to create processes and utilise resources to develop sustainable production. To have the right combination of skills to manage a forestry organisation successfully over time suggests building entrepreneurial competencies in forestry education and training programs. Increasing stakeholder pressure on the forestry sector for sustainability [29,30] supports the call for building entrepreneurial capacity in forest enterprise managers to recognise, assess, and ultimately exploit attractive opportunities created by Australia's emerging circular economy.

Overview of Sustainability in Entrepreneurship

Sustainability and life cycle redesign focused thinking contribute to meeting the objectives of the circular economy mandate [31]. The entrepreneurial method used by the forest products industry to comply with the circular economy mandate is the focus of the research.

Sustainable entrepreneurship was described as: focused on the preservation of nature, life support, and community in the pursuit of perceived opportunities to bring into existence future products, processes, and services for gain, where the gain is broadly construed to include economic and non-economic gains to individuals, the economy, and society in the study by [32]. This can include pricing waste [33,34] to manage it more effectively and pricing compliance [35] to incentivise the good behaviour of organisations to dispose of or find alternative ways to reduce waste. As the value of waste increases, more firms will innovate to exploit profitable waste management opportunities. This paper aims at highlighting diversity in entrepreneurial actions and processes that can assist in utilising these opportunities. Acknowledging strategic entrepreneurship as a way to pursue opportunities and solve problems can assist in driving industries forward and making them more sustainable. Strategic entrepreneurship supports initiatives that combine or integrate behaviours and resources aimed at developing innovations [36]. By including the three selected cases, we illustrate that the approach will depend on the entrepreneur–environment fit and availability to ensure a successful and sustained result.

3. Research Methodology

We use three case studies to illustrate similarities, differences, and alternative approaches to waste management. We draw links with the initial effectuation drivers through each of the three cases.

3.1. Biomass Resources and Usage

Converting biomass into sustainable bioenergy is one of the innovative approaches to help minimise climate change and provide an additional energy source. Recently, the EU adopted a 32% target for renewables in total gross energy consumption by 2030 [37].

Australia and the USA have developed a 20% target for renewables in gross energy consumption by 2030. Using forest waste biomass for sustainable bioenergy production is one way to achieve these renewable targets. Biomass oil can be substituted for fossil fuels and provide carbon sequestration [38]. Forest biomass can be sourced from conventional wood products, stem wood that is sustainably harvested, forest harvesting residues, and thinning materials and residues from industrial wood processing [39]. Due to its low energy density and long transport distance from remote forestry resources, forest biomass is typically used locally. Forest biomass in Australia is in the early stage of development. The country has some programs to combine firewood waste with existing coal resources in New South Wales (NSW) and a few pelletising plants, such as the Albany plant [40].

Australia's primary sources of forest biomass include forest harvesting residues, dedicated plantations for energy production, and timber mill residues [41]. The estimated weight of forest harvesting residues, the primary source of forest biomass, is about 2.1 million dry tonnes per year, according to the Australian Biomass for Bioenergy Assessment (ABBA) project. Several studies have been conducted to measure the weight of harvesting residues per hectare. This research answer calls for a more specific focus on enhancing operations management and increasing productivity and the availability of opportunities in regional areas [42,43]. The main objective of this study is an increased focus on supporting entrepreneurship and forest enterprises to manage supply chains and reduce woody waste by integrating biomass recovery into conventional harvesting practices.

3.2. Three Selected Forest Biomass Supply Chain Case Studies

Three case studies illustrate the harvesting residues that the forestry industry wastes in Australian plantations [43]. The reason for selecting case studies on harvesting residues (and excluding case studies on whole tree biomass harvesting and utilisation of thinning materials) is that there are harvesting residues left on most of the sites, and part of these residues can be collected to reuse in the production of additional valuable outputs without impacting forestry residuals that are left to maintain soil fertility and long-term site sustainability [43]. This tactic of partial utilisation of harvesting residues is aligned with the scientific recommendations provided by Brack [44], who stated that although most renewable energy policy frameworks treat biomass as though it is carbon neutral at the point of combustion, this cannot be assumed, as biomass emits more carbon per unit of energy than most fossil fuels. Therefore, only residues that are not burnt as waste or would have been left in the forest and decayed rapidly can be carbon neutral over the short to medium term.

The weight of harvesting residues on the sites after industrial wood recovery depends on various parameters such as the applied harvesting system, equipment, product type, silvicultural regime, species, site, stand age, diameter at breast height (DBH), and stand quality. Several studies have been conducted on various aspects of the weight of residues, especially the quantity and quality of the produced wood chips [45], species (including hardwood and softwood) [46,47], moisture content [48,49], machine type and its working units [46,50,51], the drive unit of the chippers including low- and high-power machine types [52,53], wear of knives' blades [54,55], and the size of sieves used in the chipping operations [56,57]. Along with the weight of residues, the applied harvesting system influences the type and dimensions of remaining and harvested residues. Cut-to-length (CTL) is a forest harvesting method that processes the trees on-site and produces sawlogs and pulpwood on-site, leaving woody materials. Study results from several plots in different locations in Australia confirmed that the cut-to-length method is widely applied in harvesting plantations. This method produces a high weight of residues, averaging 104.0 green metric tonnes per ha (GMT/ha) [44]. Ximenes [58] applied purpose-built trailers with built-in measuring devices to measure the weight of biomass proportions. Others using measuring random plots to estimate the total weight and the percentage of each component, including needles/leaves, bark, branches, stem wood, and cones in pine and Eucalypt plantations, found that the amount remaining slash at sites cleared

by cut-to-length (CTL) harvesting method (101.7 GMT/ha) was higher than at sites clear-felled by the whole tree to roadside (WTR) method (6.1 GMT/ha). This indicates that the application of whole-tree harvesting can reduce the quantity of residues left on the cut-over area and help concentrate them at the roadsides or landings, which can assist with lowering biomass recovery and processing costs compared to scattered residues produced as a result of cut-to-length operations. Based on the fraction test, the most significant parts of the remaining slash were from stem wood and branches (ranging from 23% to 38% of the total weight of residues) that can be potentially recovered for bioenergy to create additional value from existing forest resources [59–61].

Collecting residues can reduce the fire hazard by removing fuel from the forest floor, minimising beetle attack hazards, and preparing the site for tree planting [44,62]. However, collecting residues is not always easy. Thiffault [63] reviewed the recovery rates of the harvested biomass reported in over 60 studies of boreal forests, with the average biomass recovery rate in the boreal forest being 52.2%. From an ecological perspective, the harvesting residues can improve soil structure, help to resist compaction, provide a buffer against erosion, and improve water filtration [64].

3.3. Case Study 1: Collecting Harvesting Residues from Pine Plantations in Victoria

The first study site was a 31-year-old radiata pine (*Pinus radiata*) plantation near Mount Gambier, which had been clear-felled using the cut-to-length method using harvesters and forwarders. The organisation used other technology such as a Bruks mobile chipper to collect forest harvesting residues and chip and load them into the trucks while leaving sufficient residues on the site to maintain soil fertility. The produced wood chips were then transported to the Carter Holt Harvey mill in Mount Gambier as feedstock for their boiler [64,65]. This biomass supply chain created employment at every stage of the supply chain as more equipment was used (such as the Bruks Mobile chipper). Other residue processing and transport elements required extra labour. If operations such as this increased in this region to process a woody waste weight of 200,000 tonnes per year, it would increase potential employment opportunities to 15 jobs. This can be a positive contribution from the forest industry, as Schirmer [66] reported that the forest industry has contributed a total of 2344 jobs to the Green Triangle region where this case study takes place. The main drivers for the forest grower Hancock Victorian Plantations (HVP) to initiate this project were:

- (a) reducing the weight of woody waste for improving the efficiency of site preparation and planting;
- (b) creating additional value (income) from the woody resources;
- (c) testing new biomass technology in the country through an active partnership with a forest technology company;
- (d) reducing the risk of fire.

3.4. Case Study 2: Integrated Biomass Harvesting in New South Wales

The second case was conducted by Walsh [67] in a 34-year-old radiata pine plantation (near Tumut, NSW) that had been thinned twice. The trees were felled and processed by a mechanical harvester. Then sawlogs, pulpwood, and a proportion of waste woods (called Fibreplus in this case study) were collected by a forwarder to the roadside. At the roadside, the woody waste was chipped into a truck. Woodchips created from waste recovery had a high quality and were supplied to a pulp-papermaking company in the region [67]. This integrated biomass case study created jobs for one chipper operator, one forwarder driver, and one truck driver, and associated jobs were supported in Visy Pulp and Paper in NSW by increasing their wood supply. Assuming 300,000 tonnes of woody waste in the region, this innovative biomass recovery could create about 20 additional local jobs while the current employment rate by the forest industry is 3300 in NSW (www.dpi.nsw.gov.au) (accessed on 16 December 2021). The main drivers for the forest grower (Forest Corp NSW) to test the biomass harvesting recovery include:

- (a) reducing the weight of woody waste for improving the efficiency of site preparation and planting;
- (b) creating additional value (income) from their resources;
- (c) reducing fire risk associated with woody resources;
- (d) innovation on integrating biomass recovery with conventional harvesting operations.

3.5. Case Study 3: Integrated Biomass Harvesting in WA

Next, we investigated the integrated biomass harvesting in a 32-year-old *Pinus radiata* plantation located in southwest Western Australia. The area was harvested by a harvester and forwarder, where trees were felled and processed into sawlogs and pulpwood to be extracted to the roadside by a forwarder [60]. A forwarder collects residues that are not seen as waste by the growers but offer an entrepreneurial opportunity to utilise the waste and the machines usually used for sawlog and pulpwood recovery (industrial woods) in new and innovative ways.

The forest grower in WA (Forest Products Commission (FPC)) tested the recovery of harvesting residues in their plantations mainly because of the following reasons:

- (a) the success of the earlier trial (case study 2 in NSW) on using integrated biomass harvesting;
- (b) reducing the weight of woody waste for improving the efficiency of site preparation and planting;
- (c) creating additional value (income) from their resources;
- (d) reducing fire risk associated with woody resources.

The integrated biomass case study created additional jobs for a forwarder operator (due to the increased volume of harvested wood per hectare) and a chipper and truck operator to process the residue logs and transport them to the customers. Considering an assumed amount of 200,000 tonnes of woody waste in the region, this could help the forest industry to create 15 additional jobs. Currently, the forest industry in WA creates 2114 direct jobs in the regions [66].

Figure 1 illustrates the motivation for collecting and reprocessing forestry waste.

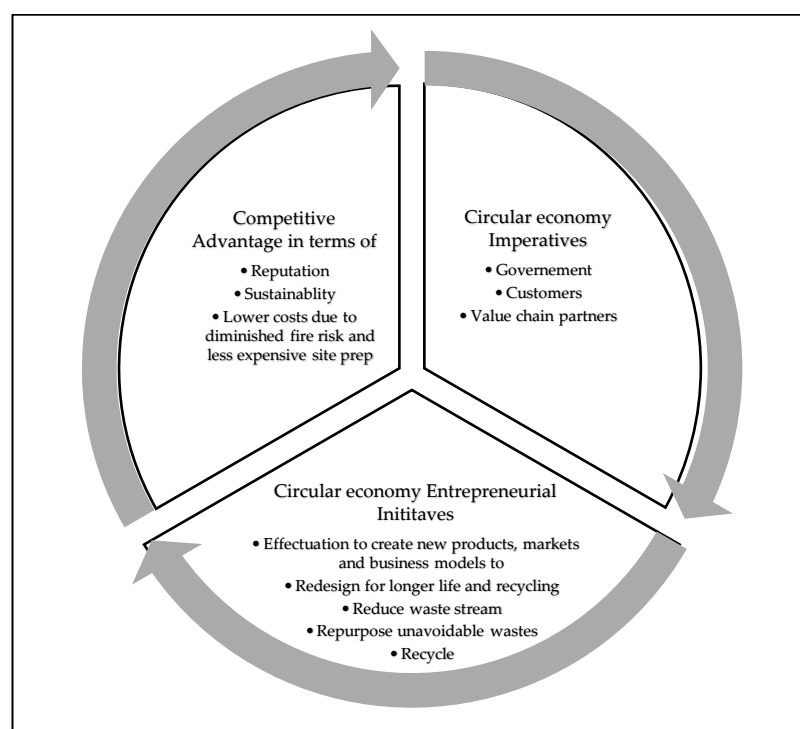


Figure 1. Circular economy imperatives and leveraging the entrepreneurial method to transform wood wastes into commercial opportunities (adapted from [17,18,68]).

Table 1 offers insights into how each of these cases entrepreneurially leveraged the forest waste to create new profitable products.

Table 1. Circular economy stage and form of effectuation by case study.

| Stage of Circular Economy ¹ | Effectual Actions ² | Case One ³ | Case Two ³ | Case Three ³ |
|--|---|--|--|--|
| Collection | What resources do we have? What skills do we have? Who would find value in these resources? | Additional biomass recovery of 20 GMT/ha Collecting harvesting residues by mobile chipper Carter Holt Harvey mill to feed their boiler | Additional biomass recovery of 23 GMT/ha Collecting harvesting residues by forwarders Visy Pulp and Paper to feed their boiler | Additional biomass recovery of 37 GMT/ha Collecting harvesting residues by forwarders Used as pulpwood in the region |
| Sorting | Will our waste customers pay for us to sort? | No | No | No |
| Recycling and re-manufacture | What supply chain partners can we develop to produce and market a waste-derived product? | Bioenergy, biochar, and cross-laminated wood producers | Bioenergy, biochar, and cross-laminated wood producers | Bioenergy, biochar, and cross-laminated wood producers |

1: Adapted from [1]. 2: Adapted from [23] and [18,69]. 3: [42].

4. Discussion and Conclusions

There are many different entrepreneurial strategies to follow and add to the valuation of waste to make social, economic, and political sense [68]. These three cases illustrate some potential ways the industry is already adapting, developing, and progressing in this regard. It is important that the support structures can guide and help organisations to sustain these efforts. It is important to note that different entrepreneur–environment combinations will lead to different approaches and strategies [70]. Some efforts do not need grand designs or policies and regulations to facilitate and monitor them. Different entrepreneurs can leverage effectuation [23], utilise what is available in their immediate environment, and create partnerships within their value chain that play to their strengths [24]. Hence, finding the right balance between entrepreneur–environment and opportunity is imperative. Each harvesting contractor provides the infrastructure and local capital to tap into, making these efforts more authentic and easier to sustain since they are local and use more of a bottom-up approach. The stakeholders in each of these ecosystems will contribute different resources but also have different expectations of the outcomes. This leads to unique and diverse approaches that produce examples for future entrepreneurs and strategies to reach sustainable outcomes for social, economic, and environmental value.

The cases used in this research help us to illustrate that there are different organisational objectives and motivations to consider these practices, but some common denominators describe the common goal of sustainability in forestry. Sustainability in forestry includes profit, people, and the planet. This translates to the effective and efficient combined effort of all stakeholders to ensure economic (costs and profit), social (employment, safety, and work environment), and environmental (waste impact and long-term effects) balance. Therefore, having a clearly articulated common goal assists in completing the processes and combining the resources through entrepreneurial strategies.

The proactive entrepreneurial behaviour of organisations to use what they have and what is most appropriate for where they should be incentivised by government and private sector support. This research provides information that can be useful to educate organisations about the value of entrepreneurial approaches and possible options, business models, and partnering opportunities to further develop markets for these products and supply chains that could assist in planning for future projects.

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References

- Schandl, H.; King, S.; Walton, A.; Kaksonen, A.H.; Tapsuwan, S.; Baynes, T.M. *National Circular Economy Roadmap for Plastics, Glass, Paper, and Tyres*; CSIRO: Canberra, Australia, 2020; p. 4. ISBN 978-1-4863-1495-9.
- York, J.G.; Venkataraman, S. The entrepreneur–environment nexus: Uncertainty, innovation, and allocation. *J. Bus. Ventur.* **2010**, *25*, 449–463. [\[CrossRef\]](#)
- Warguła, Ł.; Kukla, M. Determination of maximum torque during carpentry waste comminution. *Wood Res.* **2020**, *65*, 771–784. [\[CrossRef\]](#)
- Stevenson, K.; Stallwood, B.; Hart, A.G. Tire Rubber Recycling and Bioremediation: A Review. *Bioremediation J.* **2008**, *12*, 1–11. [\[CrossRef\]](#)
- Balakrishnan, P.; Sreekala, M.S. Recycling of Plastics: Methods, Characterisation, and Applications. In *Recycling of Polymers*; Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim, Germany, 2016; pp. 115–139. [\[CrossRef\]](#)
- Li, Y.; Gong, M.; Zhang, X.-Y.; Koh, L. The impact of environmental, social, and governance disclosure on firm value: The role of CEO power. *Br. Account. Rev.* **2018**, *50*, 60–75. [\[CrossRef\]](#)
- Ortas, E.M.; Moneva, J.; Álvarez, I. Sustainable supply chain and company performance: A global examination. *Supply Chain Manag.* **2014**, *19*, 332–350. [\[CrossRef\]](#)
- Miles, M.; Munilla, L.S.; Russell, G.R. Marketing and environmental registration/certification: What industrial marketers should understand about ISO 14000. *Ind. Mark. Manag.* **1997**, *26*, 363–370. [\[CrossRef\]](#)
- Nikolakis, W.; Cohen, D.H.; Nelson, H.W. What matters for socially responsible investment (SRI) in the natural resources sectors? SRI mutual funds and forestry in North America. *J. Sustain. Financ. Investig.* **2012**, *2*, 136–151.
- De Falco, S.E.; Scandurra, G.; Thomas, A. How stakeholders affect the pursuit of the Environmental, Social, and Governance. Evidence from innovative small and medium enterprises. *Corp. Soc. Responsib. Environ. Manag.* **2021**, *28*, 1528–1539. [\[CrossRef\]](#)
- Royston, M.G. *Pollution Prevention Pays*; Pergamon Press: New York, NY, USA, 1979.
- Ochsner, M.; Chess, C.; Greenberg, M. Pollution prevention at the 3M corporation: Case study insights into organisational incentives, resources, and strategies. *Waste Manag.* **1995**, *15*, 663–672. [\[CrossRef\]](#)
- Romero-Hernández, O.; Romero, S. Maximising the value of waste: From waste management to the circular economy. *Thunderbird Int. Bus. Rev.* **2018**, *60*, 757–764. [\[CrossRef\]](#)
- Urbinati, A.; Chiaroni, D.; Chiesa, V. Towards a new taxonomy of circular economy business models. *J. Clean. Prod.* **2017**, *168*, 487–498. [\[CrossRef\]](#)
- Hosseini, A.; Ylä-Mella, J.; Pongrácz, E. Current Status of Circular Economy Research in Finland. *Resources* **2021**, *10*, 40. [\[CrossRef\]](#)
- Lazaridou, D.; Michailidis, A.; Trigkas, M. Exploring Environmental and Economic Costs and Benefits of a Forest-Based Circular Economy: A Literature Review. *Forests* **2021**, *12*, 436. [\[CrossRef\]](#)
- Miles, M.; Covin, J.G. Environmental Marketing: A Source of Reputational, Competitive, and Financial Advantage. *J. Bus. Ethic* **2000**, *23*, 299–311. [\[CrossRef\]](#)
- Miles, M.P.; Munilla, L.S.; Darroch, J. Sustainable corporate entrepreneurship. *Int. Entrep. Manag. J.* **2008**, *5*, 65–76. [\[CrossRef\]](#)
- Ihnat, V.; Lübke, H.; Balberčák, J.; Kuňa, V. Size reduction downcycling of waste wood: Review. *Wood Res* **2020**, *65*, 205–220. [\[CrossRef\]](#)
- Tang, M.; Liu, Y.; Ding, F.; Wang, Z. Solution to Solid Wood Board Cutting Stock Problem. *Appl. Sci.* **2021**, *11*, 7790. [\[CrossRef\]](#)
- Veleva, V.; Bodkin, G. Corporate-entrepreneur collaborations to advance a circular economy. *J. Clean. Prod.* **2018**, *188*, 20–37. [\[CrossRef\]](#)
- Shane, S.; Venkataraman, S. The Promise of Entrepreneurship as a Field of Research. *Acad. Manag. Rev.* **2000**, *25*, 217–226. [\[CrossRef\]](#)
- Sarasvathy, S.D. Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Acad. Manag. Rev.* **2001**, *26*, 243–263. [\[CrossRef\]](#)
- Sarasvathy, S.D.; Venkataraman, S. Entrepreneurship as Method: Open Questions for an Entrepreneurial Future. *Entrep. Theory Pr.* **2011**, *35*, 113–135. [\[CrossRef\]](#)
- Garud, R.; Gehman, J.; Kumaraswamy, A. Complexity Arrangements for Sustained Innovation: Lessons from 3M Corporation. *Organ. Stud.* **2011**, *32*, 737–767. [\[CrossRef\]](#)
- Mehlhorn, J.E.; Bonney, L.; Fraser, N.; Miles, M. Benchmarking entrepreneurship education in u.s., australian, and new zealand university agriculture programs. *J. Dev. Entrep.* **2015**, *20*, 1550017. [\[CrossRef\]](#)
- Illia, L.; Zamparini, A. Legitimate Distinctiveness, Historical Bricolage, and the Fortune of the Commons. *J. Manag. Inq.* **2016**, *25*, 397–414. [\[CrossRef\]](#)
- Mourao, P.R.; Martinho, V.D. Forest entrepreneurship: A bibliometric analysis and a discussion about the co-authorship networks of an emerging scientific field. *J. Clean. Prod.* **2020**, *256*, 120413. [\[CrossRef\]](#)

29. Bolte, A.; Ammer, C.; Löf, M.; Nabuurs, G.-J.; Schall, P.; Spathelf, P. Adaptive forest management: A prerequisite for sustainable forestry in the face of climate change. In *Sustainable Forest Management in a Changing World*; Springer: Dordrecht, The Netherlands, 2009; pp. 115–139.
30. Boiral, O.; Heras-Saizarbitoria, I. Managing Biodiversity Through Stakeholder Involvement: Why, Who, and for What Initiatives? *J. Bus. Ethic* **2015**, *140*, 403–421. [\[CrossRef\]](#)
31. Husgafvel, R.; Linkosalmi, L.; Hughes, M.; Kanerva, J.; Dahl, O. Forest sector circular economy development in Finland: A regional study on sustainability driven competitive advantage and an assessment of the potential for cascading recovered solid wood. *J. Clean. Prod.* **2018**, *181*, 483–497. [\[CrossRef\]](#)
32. Patzelt, H.; Shepherd, D.A. Recognizing Opportunities for Sustainable Development. *Entrep. Theory Pr.* **2011**, *35*, 631–652. [\[CrossRef\]](#)
33. Dunning, R.D.; Johnson, L.K.; Boys, K.A. Putting Dollars to Waste. *Choices* **2019**, *34*, 1–9.
34. Stephan, G. Putting a price tag on emissions and resources: An economist's view on policy interventions for intergenerational fairness and sustainability. *GAIA—Ecol. Perspect. Sci. Soc.* **2020**, *29*, 215–217. [\[CrossRef\]](#)
35. Palm, J.; McBain-Charles, L.; Meyers, W. Putting a price on compliance. *ReSource* **2019**, *21*, 14–17.
36. Mazzei, M.J. Strategic entrepreneurship: Content, process, context, and outcomes. *Int. Entrep. Manag. J.* **2018**, *14*, 657–670. [\[CrossRef\]](#)
37. Scarlat, N.; Dallemand, J.; Taylor, N.; Banja, M. *Brief on Biomass for Energy in the European Union*; Sanchez Lopez, J., Avraamides, M., Eds.; Publications Office of the European Union: Luxembourg, 2019; ISBN 978-92-79-77235-1.
38. Ericson, K.; Nilsson, L. Assessment of the potential biomass supply in Europe using a resource-focused approach. *Biomass Bioenergy* **2006**, *30*, 1–15. [\[CrossRef\]](#)
39. Smith, T.; Lattimore, B.; Atkin, E. Mobilizing sustainable bioenergy supply chains. In *IEA Bioenergy Strategic Inter-Task Project*; IEA Bioenergy: Berlin, Germany, 2015; 170p.
40. Ghaffariyan, M.R.; Brown, M.; Acuna, M.; Sessions, J.; Kumar, M.; Wiedemann, J. Biomass harvesting in Eucalyptus plantations in Western Australia. *South. For.* **2011**, *73*, 149–154. [\[CrossRef\]](#)
41. Ghaffariyan, M.R. Short review on overview of forest biomass harvesting case studies in Australia. *Silva Balc.* **2019**, *20*, 89–96.
42. Maktoubian, J.; Taskhiri, M.S.; Turner, P. Intelligent Predictive Maintenance (IPdM) in Forestry: A Review of Challenges and Opportunities. *Forests* **2021**, *12*, 1495. [\[CrossRef\]](#)
43. Ghaffariyan, M.R.; Dupuis, E. Analysing the Impact of Harvesting Methods on the Quantity of Harvesting Residues: An Australian Case Study. *Forests* **2021**, *12*, 1212. [\[CrossRef\]](#)
44. Brack, D. *Woody Biomass for Power and Heat Impacts on the Global Climate*; Chatham House: Minneapolis, MN, USA, 2017; 69p.
45. Warguła, Ł.; Kukla, M.; Krawiec, P.; Wiczorek, B. Impact of Number of Operators and Distance to Branch Piles on Woodchipper Operation. *Forest* **2020**, *11*, 598. [\[CrossRef\]](#)
46. Warguła, Ł.; Kukla, M.; Wiczorek, B.; Krawiec, P. Energy consumption of the wood size reduction processes with employment of a low-power machines with various cutting mechanisms. *Renew. Energy* **2022**, *181*, 630–639. [\[CrossRef\]](#)
47. Spinelli, R.; Magagnotti, N.; Paletto, G.; Preti, C. Determining the impact of some wood characteristics on the performance of a mobile chipper. *Silva Fenn.* **2011**, *45*, 85–95. [\[CrossRef\]](#)
48. Nati, C.; Spinelli, R.; Fabbri, P. Wood chips size distribution in relation to blade wear and screen use. *Biomass Bioenergy* **2010**, *34*, 583–587. [\[CrossRef\]](#)
49. Pochi, D.; Civitarese, V.; Fanigliulo, R.; Spinelli, R.; Pari, L. Effect of poplar fuel wood storage on chipping performance. *Fuel Process. Technol.* **2015**, *134*, 116–121. [\[CrossRef\]](#)
50. Manzone, M.; Balsari, P. Productivity and woodchip quality of different chippers during poplar plantation harvesting. *Biomass Bioenergy* **2015**, *83*, 278–283. [\[CrossRef\]](#)
51. Manzone, M. Energy consumption and CO₂ analysis of different types of chippers used in wood biomass plantations. *Appl. Energy* **2015**, *156*, 686–692. [\[CrossRef\]](#)
52. Nati, C.; Eliasson, L.; Spinelli, R. Effect of chipper type, biomass type and blade wear on productivity, fuel consumption, and product quality. *Croat. J. For. Eng.* **2014**, *35*, 1–7.
53. Warguła, Ł.; Kukla, M.; Lijewski, P.; Dobrzyński, M.; Markiewicz, F. Influence of Innovative Woodchipper Speed Control Systems on Exhaust Gas Emissions and Fuel Consumption in Urban Areas. *Energies* **2020**, *13*, 3330. [\[CrossRef\]](#)
54. Spinelli, R.; Magagnotti, N. Determining long-term chipper usage, productivity and fuel consumption. *Biomass Bioenergy* **2014**, *66*, 442–449. [\[CrossRef\]](#)
55. Spinelli, R.; Glushkov, S.; Markov, I. Managing chipper knife wear to increase chip quality and reduce chipping cost. *Biomass Bioenergy* **2014**, *62*, 117–122. [\[CrossRef\]](#)
56. Han, S.-K.; Han, H.-S.; Bisson, J.A. Effects of Grate Size on Grinding Productivity, Fuel Consumption, and Particle Size Distribution. *For. Prod. J.* **2015**, *65*, 209–216. [\[CrossRef\]](#)
57. Laitila, J.; Routa, J. Performance of a small and a medium sized professional chippers and the impact of storage time on Scots pine (*Pinus sylvestris*) stem wood chips characteristics. *Silva Fenn.* **2015**, *49*, 1–19. [\[CrossRef\]](#)
58. Ximenes, F.; Stephens, M.; Brown, M.; Law, B.; Mylek, M.; Schirmer, J.; Sullivan, A.; McGuffog, T. Mechanical fuel load reduction in Australia: A potential tool for bushfire mitigation. *Aust. For.* **2017**, *80*, 1–11. [\[CrossRef\]](#)

59. Walsh, D.; Strandgard, M. Productivity and cost of harvesting a stemwood biomass product from integrated cut-to-length harvest operations in Australian *Pinus radiata* plantations. *Biomass Bioenergy* **2014**, *66*, 93–102. [\[CrossRef\]](#)
60. Ghaffariyan, M.R.; Apolit, R. Harvest residues assessment in pine plantations harvested by whole tree and cut-to-length harvesting methods (A case study in Queensland, Australia). *Silva Balc.* **2015**, *16*, 113–122.
61. Berry, M. *Plantation Residue Assessment for Bioenergy Supply—HQPlantations Toolara Southern Pine Plantation*; Internal Report; University of the Sunshine Coast: Sunshine Coast, QLD, Australia, 2018; 5p.
62. Schnepf, C.; Graham, R.T.; Kegley, S.; Jain, T.B. *Managing Organic Debris for Forest Health: Reconciling Fire Hazard, Bark Beetles, Wildlife, and Forest Nutrition Needs*; University of Idaho, Pacific Northwest Extension: Moscow, Russia, 2019; 60p.
63. Thiffault, E.; Béchar, A.; Paré, D.; Allen, D. Recovery Rate of Harvest Residues for Bioenergy in Boreal and Temperate Forests: A Review. *Adv. Bioenergy* **2015**, 293–316. [\[CrossRef\]](#)
64. Ghaffariyan, M.R.; Sessions, J.; Brown, M. Evaluating productivity, cost, chip quality and biomass recovery for a mobile chipper in Australian road side chipping operations. *J. For. Sci.* **2012**, *58*, 530–535. [\[CrossRef\]](#)
65. Ghaffariyan, M.R.; Sessions, J.; Brown, M. Collecting harvesting residues in pine plantations using a mobile chipper in Victoria (Australia). *Silva Balc.* **2014**, *15*, 81–95.
66. Schirmer, J.; Mylek, M.; Magnusson, A.; Yabsley, B.; Morison, J. Socio-Economic Impacts of the Forest Industry, Green Triangle. Available online: https://www.fwpa.com.au/images/Green_Triangle_Report_8Dec2017_published.pdf (accessed on 16 December 2021).
67. Walsh, D.; Wiedemann, J.; Strandgard, M.; Ghaffariyan, M.R.; Skinnell, J. FibrePlus' study: Harvesting stemwood waste pieces in pine clearfall. *CRC For. Bull.* **2011**, *18*, 3.
68. Morrish, S.C.; Miles, M.P.; Polonsky, M.J. An exploratory study of sustainability as a stimulus for corporate entrepreneurship. *Corp. Soc. Responsib. Environ. Manag.* **2011**, *18*, 162–171. [\[CrossRef\]](#)
69. Read, S.; Dew, N.; Sarasvathy, S.D.; Song, M.; Wiltbank, R. Marketing under uncertainty: The logic of an effectual approach. *J. Mark.* **2009**, *73*, 1–18. [\[CrossRef\]](#)
70. York, J.G.; O'Neil, I.; Sarasvathy, S.D. Exploring Environmental Entrepreneurship: Identity Coupling, Venture Goals, and Stakeholder Incentives. *J. Manag. Stud.* **2016**, *53*, 695–737. [\[CrossRef\]](#)