

What constitutes a sustainable future for the Welsh weaving industry?

Research Proposal by Sophia Watts

1. Introduction

There is a call by the Welsh Government to boost manufacturing in Wales, outlined in their publication 'A Manufacturing Future for Wales'; supporting and investing in manufacturing industries to boost the economy, maintain community links and to develop skills and technology (Welsh Government, 2021). However, the textile industry in Wales is not listed among the manufacturing sectors mentioned in the publication, and although aspects such as the preservation and enhancement of skills and culture are included amongst priorities of the plan, the focus seems to be more on developing transformative and radically innovative manufacturing industries (Welsh Government, 2021). From this an assumption could be made that not only is the Welsh textile industry not regarded by the Government as innovative, but that it may not be seen as an industry that could contribute to their "High Value Manufacturing" (Welsh Government, 2021, p.6) future vision for Wales.

In particular, the weaving industry in Wales has been an essential sector of Welsh industry in its past (Jenkins, 2005, p.7) and today, whilst some key stakeholders demand that there is a need to protect and enhance the industry (Bryan, 2017; Davies, 2017), there is currently no clear strategy to do so, with each mill quite separate. The intent of this research is to scope the true status of the sector currently and identify what may be the key elements to lead to future sustainability, potentially paving the way to developing a framework for sustainable business model innovation within the industry.

1.1 Background

For over 500 years, the weaving industry was ubiquitous across Wales, producing woollen items widely used and acclaimed (Jenkins, 2005, p.7). Now there are only a handful of mills still operating in Wales, and there is a risk of closure in the future in part due to aging workforces and lack of succession plans (Bryan, 2017; Davies, 2017). In surveying the history of the industry and its gradual decline over the years, Jenkins (2005) depicts how innovation transformed the industry, through the development of new technical methods and machinery. Examples are also presented of once thriving operations and profitable enterprises in which a lack of innovation contributed to their demise, which is echoed in the overall decline of the industry. Common issues include a lack of engagement and collaboration with competitors or other stake holders; being late to adapt and modernise; and errors in selecting markets and opportunities (Jenkins, 2005, p.50-55). It appears that similar patterns within individual businesses and across the sector have emerged over the years, suggesting a lack of intervention to redress challenges.

Today, when the weaving industry in Wales appears to be in a precarious position, there is a need to create innovative strategies to both sustain and regenerate the industry to ensure its future continuation and contribution to Wales's economy and culture. How can the weaving industry contribute to 'High Value Manufacturing' in Wales's future? In reviewing the points discussed in the Welsh Government's manufacturing plan (Welsh Government, 2021) it is possible to identify aspects which could apply to the weaving industry, including preserving cultural heritage, the benefits of rural industry for the community, and industry-specific skills retention and development. However, whilst not specifically excluded from future strategies for Welsh manufacturing, the general lack of contemporary literature on the sector might point towards a lack of interest in its inclusion.

1.2 Rationale of the proposed study

Preliminary searches have indicated that contemporary literature on the industry is almost non-existent. Studies have been undertaken in relation to assessing various aspects of sustainability in manufacturing businesses and industries (Alkaya and Demirer, 2014;

Henao, Sarache and Gomez, 2018; Hendiani et al, 2020; Malek and Desai, 2019; Zarte, Pechmann and Nunes, 2019), but there appears to be no such study specifically focused on the Welsh weaving industry. Compiling information to build a current picture of the industry will enable the identification of threats and opportunities that could hinder and help the sector develop towards a sustainable future. An important part of this is engagement with key stakeholders to assess their hopes for the future of their businesses, and the industry overall, and the level of willingness to transform or adapt to achieve this.

Defining 'sustainability' within the context of the industry will be a necessary stage in the research to ensure suggested strategies are relevant to the sector. The topic of the Circular Economy (CE) is widely discussed, particularly within manufacturing contexts (Bjørnset et al., 2021; Lieder and Rashid, 2016; Pieroni, McAloone and Pigosso, 2021). Whilst a circular, as opposed to linear, model is increasingly seen as essential to safeguarding the world's future, authors state that the two are not synonymous, and developments towards CE must be considered within a wider sustainable context (Geissdoerfer et al., 2016; Velenturf and Purnell, 2021). Community has been a key part of the Welsh weaving industry throughout its history; examples demonstrating that the two were interdependent (Jenkins, 2005, p. 60-61.). The importance of engagement and support of society is also highlighted in contemporary thought on sustainability (Jager-Erben et al., 2021). The study intends to synthesise information gathered to define and create sector-specific sustainability criteria. Further, investigating sustainable business model archetypes, and their suitability in relation to the Welsh weaving industry will provide a basis for businesses to create a route forward.

The hypothesis is that completion of this research study will highlight the threats and opportunities facing the Welsh weaving industry currently, and expose the potential the sector has in contributing to 'High Value Manufacturing' in Wales, leading towards a sustainable future.

1.3. Boundaries of the research

The focus of the proposed research is limited to the sustainability of the commercial aspect of weaving in Wales. Therefore, the key stakeholders this study seeks to engage are the commercially operating weaving mills. However, as the research pertains to the sustainable future of the industry, it is important to also engage with the potential future generation of weavers and to recognise that other stakeholders in the supply chain play a vital role in the industry's future. The scope of material explored in the literature review part of the research will be limited by the selected search platforms and key factors defined in the search strategy.

For this study, 'sustainability' will be considered from the perspective of economic, environmental, and societal concerns in equal balance (Geissdoerfer et al., 2016; Henao, Sarache and Gomez, 2018; Miller, 2020; Zarte, Pechmann and Nunes, 2019). This perspective is also reflected in the Welsh Government's definition of 'High Value Manufacturing' – "manufacturing activities which have a positive social, economic and environmental impact on the well-being of the citizens of Wales" (Welsh Government, 2021, p. 6).

This proposal will continue with a review of the literature on the topics concerned. The intended methodology will then be presented, followed by a discussion of the expected results and an evaluation of the proposed study.

2. Literature Review

In preparation for the proposed research, literature searches were made to scope the material available on the topics in question; the Welsh weaving industry; sustainability; and sustainable business models. The search strategy used cited the key topics as terms, combined with 'weaving' and 'woven' to focus the results. The search sheet in Table 1 displays the details. The searches revealed that whilst sustainability and sustainable business model innovation – in manufacturing industries and wider industry – are current and live topics, very little literature appears regarding specifically the Welsh weaving industry in any context.

Table 1. Search Sheet.

Majority of searches were on "exact phrase". All Google Scholar results exclude citations.

Search Term	Date range	Platform	Number of results
"Welsh woollen industry"	N.A.	UWTSD Library	27
"Welsh woollen industry"	2000-2021	Google Scholar	48
"Welsh woollen industry"	N.A.	Google Search	3,940
"Welsh weaving industry"	N.A.	UWTSD Library	0
"Welsh weaving industry"	N.A.	Google Scholar	0
"Welsh weaving industry"	N.A.	Google Search	65
"Sustainability in manufacturing"	N.A.	UWTSD Library	1,705
Sustainability in manufacturing	2011-2021	Google Scholar	849,000
Sustainability in woven manufacturing	2011-2021	Google Scholar	16,800
"Sustainability in woven manufacturing"	2011-2021	Google Scholar	0
"Sustainable business models"	N.A.	UWTSD Library	13,816
"Sustainable business models" (filtered by subject 'Business models' and 'sustainability')	N.A.	UWTSD Library	3,090
"Sustainable business models woven manufacturing"	N.A.	UWTSD Library	0
Sustainable business models	2011-2021	Google Scholar	1,210,000
Sustainable business models woven manufacturing	2011-2021	Google Scholar	17,300
"Sustainable business models woven manufacturing"	2011-2021	Google Scholar	0
"Sustainable business model archetypes" (filtered by subject 'sustainable development')	N.A.	UWTSD Library	323

2.1 Searches on the Welsh weaving industry

The majority of focused literature on weaving in Wales appears either within historical texts or in 'Welsh interest' blogs. The search term *Welsh weaving industry* returned little or no results on the search platforms. The term *Welsh woollen industry* generated more results on all three search sites. Google search engine returned the biggest volume of results, however these mostly related to the mills themselves, tourist information, interest blogs, and news items on the industry. On the academic platforms, a more concise list was returned. These results seemed more relevant, but failed to show much contemporary literature. Of the most relevant results, the majority relate to publications by J. Geraint Jenkins, cited to be the key literature on the history of the woollen industry in Wales (National Museum Wales, n.d.). The

Welsh Mills Society website (Welsh Mills Society, n.d.) contains quite an extensive bibliography on studies of milling topics, but the literature is either historically published, or relating to the history of the industry and associated processes.

The difference in volume of results returned from the search terms demonstrates that weaving in Wales does not have a strong identity in its own right. Rather the term 'Welsh Woollen industry' is generally used to encompass the process that weaving forms a part of – producing woven fabric from woollen yarns. Whilst this connection is desirable to maintain, as a supportive value chain, the elements are independent and specific skills and infrastructure are needed for each. A discussion of the most relevant search results follows.

Recent blogs about the Welsh woollen industry reiterate that the sector has been greatly reduced from the stature it once had, and that its future survival is uncertain (Pirie, 2021; Bryan, 2017). Whilst key stakeholders are optimistic about the potential of the industry, with a resurgence in the popularity of products over recent years, there are practical challenges that need to be overcome – namely in relation to preservation of skills and a lack of industry uptake from younger generations (Bryan, 2017). There is opportunity for collaboration between existing businesses and emerging weaver designers to bridge this gap, but the logistics of this have created barriers to being fully explored (Bryan, 2017).

Meg Pirie (2021) expresses an awareness of the benefits of increasing the value of Welsh wool, highlighting the importance of the fibre's sustainable attributes from environmental, as well as social and economic perspectives. Work by Cambrian Mountains Wool, to create a commercially available pure Welsh wool yarn to help re-establish the wool growing side of the industry (Cambrian Wool, n.d.) is echoed by the Welsh Conservative's campaign for a Welsh Wool Pledge (Welsh Conservatives, 2020; Welsh Parliament, 2020) and the new government funded project Gwaned â Gwlân (Menter Mon, 2021). Both seek to revitalise the wool growing side of the industry and to discover new uses for the fibre, increasing its value.

These developments could prove positive for weaving in Wales, presenting opportunities for the weaving industry and generating interest by association. The Gwaned â Gwlân project, and activities prior to its creation, has created a network of stakeholders across the Welsh woollen industry (Menter Mon, 2021; Business Wales, 2021); engaging parties from all parts of the value chain, facilitating the opportunity for open discussion and collaboration. However, the focus of these initiatives is on the fibre specifically and weaving essentially remains just one possible outcome for utilising Welsh wool. The lack of contemporary literature specifically on woven industry in Wales emphasises the need for the proposed study.

2.2 Searches on sustainability

In contrast, there is a vast amount of literature in relation to sustainability, concerning many aspects and industries, demonstrating that sustainability in industry is an important topic. Refining the search was necessary to identify the most relevant articles. Narrowing the search topics with the inclusion of 'weaving' returned no results on any platform. The addition of 'woven' did return some results, but most articles seemed not to relate to woven industries specifically.

To refine this information acutely is a considerable task, especially for individual businesses to extract the relevant information for their industry to create a strategy. Results show that there are many literature reviews on sustainable topics, with academics having identified this need and made efforts to present best practice concepts in a more accessible way (Bjørnbet *et al.*, 2021; Bocken *et al.* 2014; Henao, Sarache and Gomez, 2018; Lieder and Rashid,

2016; Pieroni, McAloone and Pigosso, 2019). Two topics of particular interest are now discussed.

Bocken *et al.* (2014) conducted a literature review to identify sustainable business model archetypes, refining and collating the literature into eight archetypes that are concisely defined. The research concluded that there were positives and negatives to each of the identified approaches, and therefore combinations of business model archetypes should be adopted by businesses in order to achieve true sustainability. Although this research was conducted eight years ago, Pieroni, McAloone and Pigosso (2019) state this research to be “the most cited topology”. An antithesis of this research was conducted by Bocken and Short (2021), seeking to identify unsustainable business models. The research sought to highlight any shortfalls in strategies and the reasons for sustainable approaches not being adopted and/or delivering the desired level of transformation. Whereas the earlier research took an across-industry approach, this latest research was sector-specific, presenting a stronger awareness of challenges within individual industries.

Pieroni, McAloone and Pigosso (2021) proposed a model for circular economy business model innovation for use by manufacturing companies, suggesting a step-by-step approach. Their research was in response to a lack of holistic and practical guidance for companies seeking to work towards more sustainable approaches in their operations. The resulting model is extensive. Improvements were suggested from the trial phase of the study by participating companies, concerning their desire for customised tools specific to their activities, rather than a generic guide from which to create their own process. The feedback suggests that in sustainable business model innovation, the specific context of the industry or even individual company must be considered more directly.

These perspectives reinforce the need for specific guidance to be investigated and created within industry context. The proposed study will satisfy this need by compiling and analysing relevant information focused on the Welsh weaving sector. The synthesised information in these previous studies creates a useful platform from which to build on when researching sustainability in relation to the Welsh weaving industry, and further research on similar papers will form part of the methodology of this proposed research.

3. Methodology

The methodology to conduct the research will be split into three main phases: 1) an investigation into the current status of the industry; 2) defining ‘sustainability’ in the context of the Welsh weaving industry; and 3) an exploration of sustainable business model innovation opportunities. This method has been devised for the collection of primary data as initial basic research, which will provide the groundwork and context within which to frame further applied research (Dudovskiy, n.d.). The latter will be conducted through predominantly, but not exclusively, secondary research throughout the process.

3.1 Phase One – Investigation into the current status of the industry

It is important to gauge the true situation of the weaving industry in Wales directly from the primary stakeholders, to identify the main threats and opportunities the sector faces. The key stakeholders include: the mills still in operation; representatives from higher education in weave practices; and other businesses within the wool and weaving supply chain in Wales. The intention of gathering different perspectives is to build a well-rounded view of the industry, in an effort to avoid bias or myopia.

Areas to investigate include: the volume of businesses operating in the sector; succession plans of current owners; the ability to preserve and transfer key skills; and access to

technology. It will also be important to ascertain business' willingness to engage in the research, in collaboration, and in innovative transformation. This information will be gathered initially through questionnaires, comprising set questions but allowing for some open answers. This will prepare the ground, highlighting common responses and anomalies. The key themes will be extracted manually, employing a method such as framework analysis (Goldsmith, 2021), to compile the data in a simplified matrix format. The engagement with the questionnaires will help to focus and determine the content of follow-up interviews with key stakeholders, through which more individual detail can be gathered. Set questions for the interviews will be devised, but the intention is to follow a conversational format to reveal commentary and open discussions that may not be articulated through simple question and answer. The interviews will be conducted face-to-face where possible, either in person or remotely online, and will be audio or video recorded as appropriate, allowing for the content to be transcribed, analysed, and collated. The two-step data-collection process of questionnaires and interviews is important to allow both statistical and contextual information to be gathered.

3.2 Phase Two – Defining 'sustainability' in the context of the Welsh weaving industry

The information collected in Phase One will be categorised under economic, environmental, and societal concerns to identify what these sustainability elements comprise in the specific context. The data will be organised into a simple table, for ease of reference in the next stages of the research.

A more in-depth literature review of sustainability in the woven textiles manufacturing sector will then be conducted. A search strategy will be devised allowing the search field to be refined to return focussed results. The key topics, terms and concepts will be defined for use as search terminology, and a systematic process to categorise and analyse the literature will be created. Thematic networks (Attride-Stirling, 2001) can be used to organise the extracted data into central themes. Both academic sources and examples of best practice in industry will be researched, with opportunities for case studies to be identified. Therefore, the search platform will be broadened to include international literature and media channels. The key considerations extracted from the literature will be compiled into tables, allowing for objective review in relation to the threats and opportunities highlighted during discussions with stakeholders.

The results of the research in Phase Two will be synthesised to create criteria for the assessment of suitability of different sustainable business model archetypes in relation to the Welsh weaving industry. This will be achieved by creating an interface of the identified economic, environmental, and societal sustainability concerns, with best practice examples from the literature. The criteria will be presented in a framework to facilitate cross-referencing in the decision-making process, with regards to sustainable business model innovation.

3.3 Phase Three - Exploration of sustainable business model innovation opportunities

Archetypes of sustainable business model innovation and suggested strategies, as explored by other academics such as Bocken *et al.* (2014) and Bocken and Short (2021), will be assessed for suitability of adoption in the Welsh weaving industry, employing the criteria framework created in Phase Two. This will be performed as a discussion on the potential positives and negatives, seeking to present an evaluation of options rather than a conclusion. Examples of best practice also identified in Phase Two will be explored in greater detail through case studies, highlighting the challenges met and methods to overcome these, for consideration in the sector context. The case studies will be conducted

initially through secondary research, and expanded on through primary research where possible; employing framework analysis may be useful for this process (Goldsmith, 2021). Finally, the main potential barriers to transforming to sustainable business models will be identified from the research, to discover obstacles that may apply to weaving in Wales. Key stakeholder perspectives on these barriers will be sought through questionnaires, analysis of which will determine if these are common or particular to individual businesses in the sector.

4. Results

It is expected that the results of the study will comprise a collection of potential strategies and themes for consideration, rather than a singular outcome or route map. The objective is that the study will produce, in a sector-specific context: a clarification of sustainability threats and opportunities, categorised under economic, environmental, and societal concerns; a sustainability criteria framework; and a discussion on sustainable business model innovation opportunities, including case studies of best practice and considerations of barriers to implementation.

4.1 Data Collection and Analysis

The majority of the data collected throughout the three proposed research phases will be qualitative in nature, but quantitative results will also be captured. In Phase One, analysis of the questionnaires is anticipated to produce some quantitative results, in terms of statistics of commonality across responses. However, it is expected that the interviews in Phase One, and the information collated in Phases Two and Three will be mainly qualitative data, which is important to allow for specific context.

The use of thematic networks in Phase Two's literature review may be a useful method to extract and categorise key themes from the expanse of information available, to focus and facilitate the analysis of the data. To employ this method, the key concepts to be explored must be defined with clear limitations from the outset (Attride-Stirling, 2001). The benefit of the presenting the identified themes in the web-like format is that it creates a clear visualisation of relationships (Attride-Stirling, 2001).

Framework analysis is a useful tool in the process of analysing both primary and secondary research, although the iterative nature of the steps defined in the process lends itself particularly to primary research where feedback can be more easily obtained (Goldsmith, 2021). Taking this iterative approach allows for continual review of the concepts highlighted, and the organisation and definition of these (Goldsmith, 2021), facilitating a thorough analysis of the data collected. The stepped process also creates a level of transparency, which can be beneficial in communicating findings with stakeholders and the study's audience, assisting greater understanding of how deductions were reached (Goldsmith, 2021).

4.2 Testing the hypothesis

Building good communicative relationships with participants in Phase One of the methodology would enable a reiterative feedback process, as appropriate, throughout the research activity. Feedback from key stakeholders on the outcomes drawn from the research would enable the hypothesis to be tested, by assessing the feasibility of implementing suggested strategies in the Welsh weaving sector. However, to truly test the hypothesis, further studies would need to be undertaken monitoring the progress and outcomes of utilising the sustainability criteria framework, and additional considerations, in creating and implementing strategies within the sector. Further feedback collected throughout the study

would be in questionnaire format, creating additional quantitative data through statistical responses and consensus, rather than individual commentary or bias.

5. Evaluation

The proposed research has the potential to create a positive impact within the weaving sector in Wales, as a step towards facilitating the process of creating sustainable business model strategies for the future of the industry. The methodology employed also presents an example that could be adapted for use in similar research studies on the sustainability of other industries in Wales and beyond.

This research does not seek to draw finite conclusions on the topic raised nor to create singular guidance. The initial research conducted has highlighted the importance of tailoring strategy within the context of individual business operations, and therefore this could only be done through close collaboration with the key stakeholders concerned. Rather, the intention is that completion of the research will refine the broad landscape of sustainability literature and best practice, to create a concise and relevant framework for assessment and decision-making in the sector, regarding its sustainability.

The breadth of the proposed study will build on the research by other academics concerning sustainability in manufacturing. The proposed study will contribute further by refining and reviewing the data to create a sector-specific analysis. The intention is that this research will help to give more exposure to the potential the now diminished woven manufacturing sector has in contributing to 'High Value Manufacturing' in Wales, creating a basis from which the primary stakeholders could develop strategies to this end. Completion of the study will create a clarification of 'sustainability' within the context of the industry, highlighting the threats and opportunities, and how these could impact its future.

The main limitations of the proposal in gathering primary research relate to the stakeholders' willingness to engage, and the use of qualitative data, which presents only that which can be articulated by participants, and does not prevent omissions or bias opinion. Although efforts will be made to capture associated information, the actual exchange may be limited by the questions posed. Language could cause a potential weakness; as the intended participants span Wales it is likely that some may prefer to communicate in Welsh, which could present a barrier to engagement. This could be resolved by hiring an interpreter, and the possibility of bilingual communication could be explored. Ethical factors of undertaking the research, particularly in relation to communications with stakeholders, should be considered, for example in honouring confidentiality of sensitive information and in conducting the research with an empathic and open-minded approach.

In relation to secondary research, there is the possibility information and perspectives could be missed in the literature review, and the potential of bias both from information presented and in the analysis of it. Whilst the search strategy and method of analysis should seek to encompass all relevant data, the boundaries created to focus the information extracted will naturally exclude some elements which could provide an expansion or contradiction of thought. A broad scope of perspectives should help to minimise the impact of this, and particular care must be taken to avoid placing emphasis on the benefits or detriments of concepts explored without evidence.

In setting a timeframe for completing the research, realistic deadlines for engagement of communications and analysis of the data in Phase One must be set to allow enough time for the thorough investigation and completion of the following Phases. As Phase One creates the foundation for the following research stages, this may require some flexibility to capture as many key perspectives as possible. Compromises might need to be made on the range of

key stakeholders participating in the research, however, if it is not possible to engage them within the necessary schedule for Phase One.

In summary, the completion of the proposed study will contribute to the minimal contemporary literature on the Welsh weaving industry, exploring which sustainable strategies could be implemented by the sector, to support Wales's future economy, environment, and society.

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