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Material Utilization Practices in *Weweldeniya* Craft Community, Sri Lanka

DESHANIKA. S.N.T.[1]*, **NUGAWELA. C.T** [2]
[1, 2]*Department of Integrated Design, Faculty of Architecture, University of Moratuwa, Moratuwa, Sri Lanka*
[1]*thilini.deshanika18@gmail.com* , [2]*nugawelac@uom.lk*

Abstract — *The craft industry in Sri Lanka has been an integral part of the economy for centuries, contributing to both rural livelihoods and national trade. The Weweldeniya craft community in Sri Lanka has a rich heritage of producing intricate and culturally significant craft items using traditional techniques. However, the industry faces pressing challenges primarily due to sourcing materials from various geographic locations, incurring substantial transportation costs. To address these multifaceted challenges, the craftsmen have adopted a resource optimization strategy aimed at minimizing waste and maximizing resource utilization. This study investigates the materials commonly used in Weweldeniya crafts, their integration into production, and the techniques employed to transform raw materials into finished products. It examines the sustainable practices adopted by craftsmen to optimize resources, with a focus on the 3R principles (Reduce, Reuse, Recycle) and lean manufacturing pull systems. Findings highlight that despite economic pressures, craftsmen effectively manage resources, particularly various rattan varieties, to meet market demands. This research employs a mixed-methods approach while dominating qualitative approach to provide a comprehensive understanding of the intricate material utilization practices and sustainability. The study concludes that Weweldeniya craftsmen, despite facing rising transportation costs and fuel prices, have demonstrated adaptability through resource optimization. However, waste analysis reveals that offcuts and trimmings account for 40% and 27% of production waste, respectively, highlighting the need for better waste management and recycling practices. Enhancing technological integration and recycling could drive further innovation and skill development. Addressing these areas will be vital for sustaining the rattan industry in Weweldeniya.*

Keywords: *Material Utilization; Weweldeniya Craft Community; 3R Principles; Lean Manufacturing Pull System; Waste Reduction*

**Contact: Phone +94-773668318*
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I. Introduction

Sri Lanka's rich cultural heritage is reflected in its diverse array of crafts, which have earned global recognition and played a significant role in the country's economic and societal development for centuries. These crafts, often considered small enterprises, are vital to the traditional industries of rural economies, significantly contributing to overall economic growth.

The *Weweldeniya* Craft Community is a prominent and culturally significant group known for its traditional craft techniques and exquisite handmade products, primarily made from rattan. Despite the lack of organized rattan cultivation locally, the community has relied on wild-harvested rattan. However, due to dwindling local supplies, over 60% of the rattan used in the *Weweldeniya* cane furniture industry is imported from countries such as Indonesia, Singapore, Malaysia, Thailand, and India (Amarasekera & Dheerasekera, 2021). Currently, the industry faces significant challenges, particularly in resource scarcity, threatening its sustainability. Modern material utilization theories and techniques have become essential for optimizing production processes and minimizing waste, crucial for the survival and growth of this traditional craft sector.

II. Need of the Research

The *Weweldeniya* craft community faces unprecedented challenges in sustaining its age-old traditions while adapting to contemporary demands. A central and pressing issue that plagues this community is the effective utilization of available materials in the face of resource shortages and the escalating costs of raw materials. Understanding and documenting the *Weweldeniya* rattan industry's commitment to sustainable initiatives helps to offering innovative strategies for maximizing resource use and minimizing environmental and social impacts while presenting the research findings to fill in knowledge gaps about the context and practices of the sector for fostering sustainable development within the *Weweldeniya* craft industry.

III. Scope and Limitations

The primary limitations of the research on material utilization practices within the *Weweldeniya* craft community stem from potential selection biases inherent in the methodology. The study relies predominantly on surveying and interviewing craftsmen, which introduces the risk that participants may not offer a fully representative sample of the entire community. Furthermore, the absence of comprehensive historical records and documented traditional crafting techniques and materials poses a challenge in accurately tracing the evolution of these practices.

IV. Literature Review

Material utilization involves strategies and practices to maximize the efficient use of materials in various industries and processes. These principles are essential for achieving waste reduction, resource conservation, and enhancing sustainability in production and manufacturing.

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A. Reduce, Reuse, Recycle (3R)

The 3R concept (Reduce, Reuse, Recycle) is a structured approach to waste management that prioritizes minimizing waste generation. The primary emphasis is on reduction, followed by reuse and recycling practices, which allow for the secondary use of materials before considering landfill disposal (Bahraini, 2019).

B. Lean Manufacturing

Lean manufacturing is a systematic production approach aimed at minimizing waste and maximizing customer value. Originating from the Toyota Production System (TPS), it has been widely adopted across various industries (Landau, 2023). Its core principles focus on enhancing efficiency, reducing costs, and improving productivity while delivering high-quality products or services. The five key principles of lean manufacturing are customer value, value stream mapping, creating flow, implementing a pull system, and continuous improvement (Kaizen).

C. Circular Economy

The circular economy takes inspiration from nature and strives to maintain a closed-loop system for raw materials. This approach maximizes resource utilization, minimizes the demand for new resources, reduces waste, and extends the life cycle of products. In essence, it transforms today's waste into tomorrow's raw materials, a fundamental contrast to the linear economic system where products are created, used, and discarded (Lenzing, n.d.).

D. Implementations of Material Utilization Concepts in Rattan Industry

In every country where relevant information is accessible, a discernible and rapid depletion of rattan resources is observed, particularly for species of commercial value and those with substantial diameters (Hirschberger, 2011). As global environmental awareness grows, it is crucial for rattan product manufacturers to adopt and refine more efficient and methodical approaches for selecting and utilizing rattan materials.

In Indonesia, a technique has been identified for utilizing waste generated in the rattan industry, focusing on reusing and recycling materials produced during the splitting stage using a water and NaOH solution (Sumarno et al., 2022). Additionally, Indonesia has implemented a recycling method for rattan waste from debarking, cutting, skinning, and coring processes, which often results in chips or dust (Astari et al., 2019).

Desa Trangsan, Sukoharjo in Indonesia implemented Zero waste concept in response to the new normal situation resulting from the COVID-19 pandemic. Craftsmen eliminate waste from production process to consumer usage as a waste minimization strategy (Kurniawan et al., 2023). Meanwhile, the furniture manufacturing industry in Malaysia has adopted the circular economy concept by utilizing significant waste from rattan raw materials, particularly rattan poles. This waste, often disposed of through environmentally harmful practices like open burning and illegal dumping, poses considerable environmental challenges (Ariffin et al., 2021).

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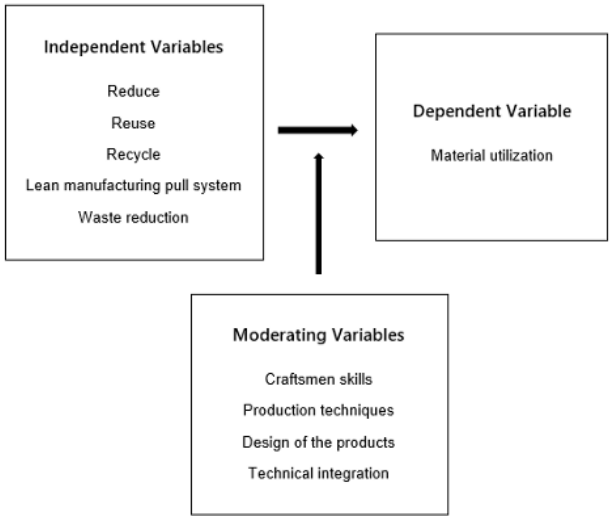
V. Conceptual Framework

The research aims to explore material utilization practices in the *Weweldeniya* craft community, emphasizing alignment with 3R (Reduce, Reuse, Recycle) principles and lean manufacturing. The conceptual framework integrates these principles and strategies as independent factors, focusing on material utilization as the dependent variable. Moderator variables are included based on existing literature that further enrich the framework, providing a structured approach for analysis and interpretation.

Figure 1

The conceptual framework (Source: Author)



VI. Methodology

Exploratory descriptive research is suitable for investigating material utilization practices in the *Weweldeniya* craft community, as the research questions aim to explore and describe the types of materials used, the integration processes, and the implementation of sustainable strategies and techniques. The study is structured into five phases, each designed to systematically explore and describe the material utilization practices in the community.

A pilot study was conducted as an initial investigation to assess the environmental factors, craftsmen's practices, their responses, and any constraints or limitations encountered. This preparatory phase aimed to validate and optimize research methodologies and procedures, ensuring their appropriateness and effectiveness. The study demonstrates a mixed-method research design, with a qualitative dominant focus. The qualitative approach will provide in-depth insights into the material utilization practices in the *Weweldeniya* craft community, while quantitative data will be used to supplement and validate qualitative findings.

The main methods of data collection included semi-structured interviews with narrative questions, questionnaire surveys, and video observations. Semi-structured interviews were utilized to foster

*Contact: Phone +94-773668318
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open-ended discussions, guided by a protocol of narrative questions strategically designed to evoke detailed and context-specific responses from the participants. Video observation sessions were conducted within the workshops of selected enterprises.

Figure 2

The research plan and structure (Source: Author)

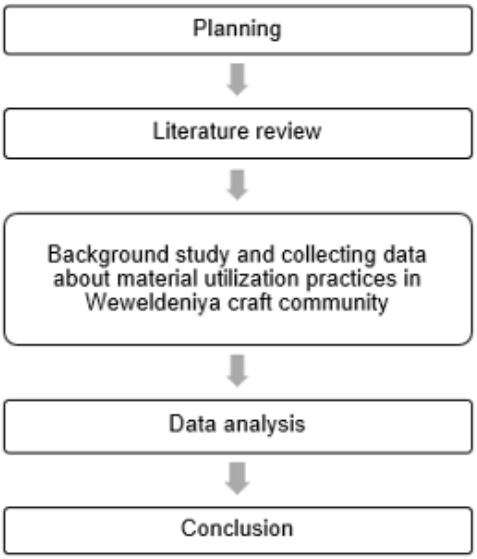

Table 1

Assessment of Craft Item Categories Across Production Process Stages

Item category	Size category	Stage code						
		A	B	C	D	E	F	G
Item category 1	Size category 1							
	Size category 2							
Item category 2	Size category 1							
	Size category 2							

The research analysis categorized craft production into distinct stages: selection (Stage A), scraping (Stage B), bending (Stage C), assembling (Stage D), splitting (Stage E), weaving (Stage F), and finishing (Stage G). Craft items were systematically evaluated based on their progression through these stages, aligning with their respective stages of production.

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The evaluation assesses each craft category's production stages within the 3R (Reduce, Reuse, Recycle) framework. Compliance with 3R principles is represented by a checkmark symbol () to indicate implementation, conversely a negative mark (-) denotes non-adherence or absence of compliance in the evaluated stages.

Table 2

Assessment of Production Stages of Craft Item Categories Within 3R Framework

Item category	Size category	Stage code	Reduce	Reuse	Recycle
Item category 1	Size category 1	A			
		B			
		C			
		D			
		E			
		F			
		G			

The study examined the relationship between independent variables and moderating variables concerning the integration of material utilization practices in crafts production. The identified moderating variables encompass craftsmen skill, production techniques, product design, and technical integration. The impact of these moderating variables on initiatives related to the 3R principles was depicted using symbols: a plus mark (+) denoted a positive impact, a minus mark (-) indicated a negative impact, and a zero mark (0) signified a neutral impact on these initiatives.

Table 3

Alignment of Material Utilization Practices in Crafts Production Stages with Sustainable Principles and Associated Moderating Variables

Stage Code	Material utilization practices		Moderating variable and Impact			
	Principle	Utilization practice	Craftsmen skill	Production techniques	Product Design	Technology integration
Code 1	Principle 1					
	Principle 2					
	Principle 3					

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VII. Data presentation and Analysis

The available merchandised products in the *Weweldeniya* craft community are systematically categorized into several classifications, each delineated by specific functional and length parameters. (Large: Items with a length of 4 feet or more, Medium: Items with lengths ranging from 1 to 3 feet, Small: Items with a length less than 1 foot)

Table 4

Classification of Products According to the Size and Functional Parameters

Size category	Utilitarian items	Ornamental ware	Furniture	Utilitarian ornamental items	Utilitarian furniture items	Ornamental furniture items	Utilitarian ornamental furniture items
Large size products	-	Lampshades	Veranda chairs, Rocking chairs, Sofa sets, Shelves	-	Book shelves	Swing chairs, Rocking chairs	Window blinds
Medium size products	Food covers, Vegetable baskets, Market bags, Hamper bags, Hamper boxes, Winnowing fans	Lampshades, Ornamental animal figures	Tables, Chairs, Veranda chairs, Shelves	Toys	Wall shelves	Swing chairs	-
Small size products	Flower baskets, Storage boxes, String hopper moulds, Hamper boxes, Cutlery storage baskets	Lampshades, Ornamental animal figures	-	Cup holders, Fashion bags, Jewellery boxes, Stationary holders, Purses, Toys	-	-	-

Rattan waste is generated throughout the production process of each category from various sources, including the disposal of low-quality rattan due to fungal infestations and immature states, as well as from peeling, bending, end cutting in weaving, and other processing stages. The percentage of waste generated varies at each stage, influenced by the specific craft item and its size category, revealing distinct patterns in waste generation.

Table 5

Waste Percentage of Craft Item Categories According to the Composition

Item category	*Size category*	*Stage code*						
		A	*B*	*C*	*D*	*E*	*F*	*G*
Utilitarian items	*Medium*		*8%*	*10%*	*20%*	*15%*	*35%*	*4%*
	Small		*6%*	*-*	*25%*	*15%*	*42%*	*4%*
Ornamental ware	*Large*		*7%*	*8%*	*22%*	*10%*	*40%*	*5%*
	Medium		*6%*	*5%*	*25%*	*10%*	*42%*	*4%*
	Small		*6%*	*-*	*25%*	*12%*	*45%*	*4%*
Furniture	*Large*		*6%*	*10%*	*20%*	*12%*	*40%*	*4%*
	Medium		*5%*	*12%*	*20%*	*12%*	*40%*	*3%*
Utilitarian Ornamental items	*Medium*	*8%*	*5%*	*8%*	*20%*	*13%*	*42%*	*4%*
	Small		*6%*	*-*	*28%*	*10%*	*45%*	*3%*

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Utilitarian Furniture items	*Large*		*6%*	*12%*	*30%*	*10%*	*30%*	*4%*
	Medium		*6%*	*12%*	*35%*	*10%*	*25%*	*4%*
Ornamental Furniture items	*Large*		*5%*	*10%*	*20%*	*12%*	*42%*	*3%*
	Medium		*6%*	*10%*	*20%*	*12%*	*40%*	*4%*
Utilitarian Ornamental Furniture items	*Large*		*5%*	*-*	*25%*	*40%*	*20%*	*2%*

Each production stage of craft item categories is systematically analysed within the framework of the 3R principles: Reduce, Reuse, and Recycle (Figure 06).

Table 6

Analysis of Production Stages of Craft Item Categories Within 3R Framework

Item category	Size category	Stage code	Reduce	Reuse	Recycle
Utilitarian items	Medium	A	✓	✓	-
		B	-	-	-
		C	✓	-	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Small	A	✓	✓	-
		B	-	-	-
		C	Process not involved		
		D	✓	-	-
		E	-	✓	-
		F	-	-	-
		G	-	-	-
Ornamental ware	Large	A	✓	✓	-
		B	-	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Medium	A	✓	✓	-
		B	-	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Small	A	✓	✓	-
		B	-	-	-
		C	Process not involved		
		D	✓	-	-
		E	-	✓	-
		F	✓	-	-
		G	-	-	-
Furniture	Large	A	✓	✓	-
		B	✓	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Medium	A	✓	✓	-
		B	✓	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
Utilitarian ornamental items	Medium	A	✓	✓	-
		B	-	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Small	A	✓	✓	-
		B	-	-	-
		C	Process not involved		
		D	✓	-	-
		E	-	✓	-
		F	✓	-	-
		G	-	-	-
Utilitarian furniture items	Large	A	✓	✓	-
		B	✓	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Medium	A	✓	✓	-
		B	✓	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
Ornamental furniture items	Large	A	✓	✓	-
		B	✓	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
	Medium	A	✓	✓	-
		B	✓	-	-
		C	✓	✓	-
		D	✓	✓	-
		E	-	✓	-
		F	✓	✓	-
		G	-	-	-
Utilitarian ornamental furniture items	Large	A	✓	✓	-
		B	-	-	-
		C	Process not involved		
		D	✓	✓	-
		E	-	✓	-
		F	-	✓	-
		G	-	-	-

(Stage codes: A- Selection, B- Scraping, C- Bending, D- Assembling, E- Splitting, F- Weaving, G- Finishing)

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Analysis of the integration of material utilization practices in crafts production aligned with the 3R (Reduce, Reuse, Recycle) principles, alongside their corresponding moderating variables are delineated below (Figure 07).

Table 7

Alignment of Material Utilization Practices in Crafts Production Stages With 3R Principles and Associated Moderating Variables

Stage Code	Material utilization practices aligned with 3R principles		Moderating variable and Impact			
	3R Principle	Utilization practice	Craftsmen skill	Production techniques	Product Design	Technology integration
A	Reduce	Prioritize and identify rattan specimens displaying the highest incidence of defects during the selection process.	+	+	0	0
	Reuse	Use immature rattan for binding purposes in the production of certain products.	0	+	+	0
	Recycle	-				
B	Reduce	When designing furniture, utilitarian furniture and ornamental furniture incorporate rattan in its natural state, retaining the epidermis, to align with customer preferences and serve the purpose of minimizing material removal.	+	+	+	0
	Reuse	-				
	Recycle	-				
C	Reduce	Employ 15ft length rattan poles directly for bending cane, utilizing the surplus sections for crafting other products.	+	+	+	0
	Reuse	Utilize cutoffs and discarded sections of bent poles to craft smaller components such as handles for various products.	0	+	+	0
	Recycle	-				
D	Reduce	When constructing the product's structure, employ both 6ft and 15ft rattan poles in their original lengths, while repurposing any surplus sections for the creation of other products.	+	+	+	0
	Reuse	Employ offcuts resulting from assembly processes to create basket items, while also providing additional components for crafting baskets aimed at the gem industry in the Meerigama area, offered at a reasonable price.	+	+	+	0
	Recycle	-				
E	Reduce	-				
	Reuse	Utilize potentially split rattan pieces to craft smaller items such as baskets.	+	+	+	0
	Recycle	-				
F	Reduce	Utilize 6ft rattan strips in their original length directly during the weaving process.	+	+	0	0
	Reuse	Employ trimmed strips, specifically ranging from 15cm to 30cm in length, for weaving small baskets and string hopper moulds.	+	+	+	0
	Recycle	-				

(Stage codes: A- Selection, B- Scraping, C- Bending, D- Assembling, E- Splitting, F- Weaving, G- Finishing)

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Throughout the production stages, five distinct types of leftovers are generated: offcuts, trimmings, strands, dust, and discarded materials. The majority of waste generated in craft production consists of offcuts, comprising 40% of total waste, and trimmings, accounting for 27%. A significant trend observed is that a substantial portion of waste materials in these categories falls within the length range of 15cm to 30cm.

Table 8

Analysis of Reusable Waste Generation within Craft Categories and their Intended Applications

Item category	Size category	Reusable waste materials		Intended applications
		Type	Size	
Utilitarian items	Medium	Offcuts	Above 15cm	Make parts of fruit baskets
		Trimmings	Above 20cm	Weave string hopper moulds
	Small	-	-	-
Ornamental ware	Large	Offcuts	Above 15cm	Make parts of cake baskets, fruit baskets
			Above 30 cm	Make handles of products, crafting gem baskets
		Trimmings	Above 20cm	Weave baskets
	Medium	Offcuts	Above 15cm	Make parts of cake baskets, fruit baskets
		Trimmings	Above 20cm	Weave baskets, string hopper moulds
	Small	-	-	-
Furniture	Large	Offcuts	Above 15cm	Make baskets, smaller parts of products
			Above 30cm	Make handles, small products and crafting gem baskets
		Trimmings	Above 20cm	Weave small products
	Medium	Offcuts	Above 15cm	Make handles parts of baskets
		Trimmings	Above 20cm	Weave small products
Utilitarian ornamental items	Medium	Offcuts	Above 15cm	Make fruit baskets and cake baskets
		Trimmings	Above 20cm	Weave small products
	Small	-	-	-
Utilitarian furniture items	Large	Offcuts	Above 15cm	Make baskets, smaller parts of products
			Above 30cm	Make handles, small products and crafting gem baskets
		Trimmings	Above 20cm	Weave small products
	Medium	Offcuts	Above 15cm	Make fruit baskets and cake baskets
		Trimmings	Above 20cm	Weave small products
Ornamental furniture items	Large	Offcuts	Above 15cm	Make baskets, smaller parts of products
			Above 30cm	Make handles, small products and crafting gem baskets
		Trimmings	Above 20cm	Weave small products
	Medium	Offcuts	Above 15cm	Make fruit baskets and cake baskets
		Trimmings	Above 20cm	Weave small products
Utilitarian ornamental furniture items	Large	Offcuts	Above 15cm	Make baskets, smaller parts of products

In the manufacturing framework of the *Weweldeniya* craft community, small and micro-level enterprises adhere to a structured production process. Emphasizing the Pull system of Lean manufacturing, this approach focuses on producing goods in response to actual demand rather than relying on forecasts or pushing products into the market.

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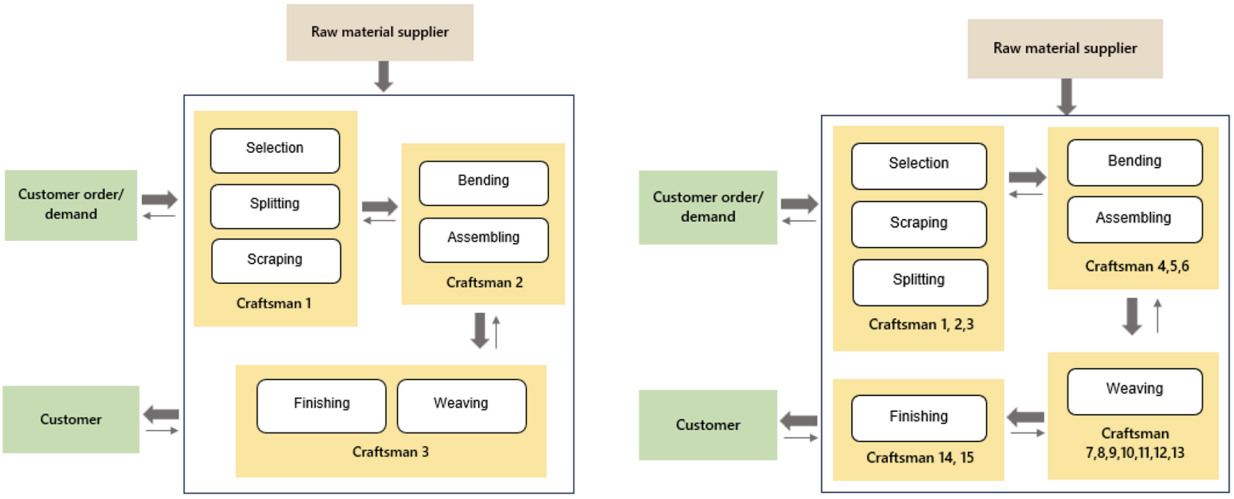
Figure 3

Production process employed by micro-level enterprises with 3 employees and small-level enterprises with 15 employees (Source: Author)



VIII. Discussion and Research Findings

Within the 3R (Reduce, Reuse, Recycle) framework, there is a discernible deficiency in the implementation of utilization strategies during the scraping and finishing stages of furniture production. For both utilitarian and ornamental furniture, the reduce strategy is effectively employed through the use of rattan in its natural state, retaining the epidermis. This approach aligns with customer preferences and minimizes material removal. However, during the splitting stage, the use of hand tools, essential for the process, paradoxically increases wastage, indicating a lack of effective reduction strategies. Nevertheless, the reuse of split rattan for smaller items helps mitigate some waste. Notably, the production of small items lacks integrated utilization strategies, highlighting a significant gap in waste management, while larger and medium-sized items demonstrate better incorporation of the 3R strategies, enhancing material utilization and waste reduction.

The analysis of material utilization practices within crafts production, aligned with 3R principles and moderating variables reveals key observations. Technology integration has a neutral impact on existing material utilization practices, but production techniques positively influence current reduction and reuse practices. Additionally, craftsmen's skills and product design significantly enhance most reduction and reuse practices. Notably, no recycling methods are observed in the assessed craft production methodologies. To reduce waste, craftsmen utilize rattan fully during crafting, sometimes without scraping the epidermis, and predominantly use 6ft and 15ft sections directly in bending, assembling, and weaving processes. Throughout production, five types of leftovers are generated: offcuts, trimmings, strands, dust, and discarded materials, with offcuts comprising about 40% and trimmings about 27% of total waste. Offcuts exceeding 15cm reused in crafting smaller items and product handles, while those over 30cm pieces are repurposed for specific baskets, catering to the gem industry in Meerigama. Trimmings over 20cm are used in

*Contact: Phone +94-773668318
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weaving string hopper moulds and smaller products, promoting sustainable utilization of leftover materials.

Craftsmen operate within a collective workflow aimed at fulfilling customer orders, characterized by a counter-directional flow of information tailored to customer needs. This facilitates real-time product evaluation and adjustments, significantly impacting waste reduction and ensuring efficient resource utilization through continuous scrutiny and optimization of craft creation stages.

IX. Conclusion

In conclusion, the challenges faced by *Weweldeniya* craftsmen in the rattan industry, such as high transportation costs and escalating fuel prices, threaten the sustainability of this craft community. Their response through strategic resource optimization has revealed diverse strategies aimed at minimizing waste and maximizing material efficiency. The study underscores the craftsmen's adaptability in utilizing various rattan varieties to meet market demands, while also highlighting opportunities for innovation in crafting techniques to reduce combustion-related wastage. The application of the 3R framework identifies both commendable practices and areas needing improvement, particularly in smaller product crafting and the integration of technology. Approximately 40% of generated waste consists of offcuts, with trimmings contributing around 27%, suggesting opportunities for more comprehensive waste management strategies. The integration of technology and recycling methods is identified as areas for improvement, underscoring potential for innovation and skill development among craftsmen. Moving forward, addressing these gaps and leveraging the structured production framework within the community will be crucial for minimizing waste, optimizing resource use, and ensuring the long-term viability of the rattan industry in *Weweldeniya.*

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**Contact: Phone +94-773668318*
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