

Community Perspectives on Sustainable Innovation through Palm Frond Utilization in Oman

Saada Al Habsi

Health, Safety Environment and Management Department, International College of Engineering and Management,
Muscat, Oman

Email: saada@icem.edu.om

ORCID: 0009-0005-9262-2732

Azza Al Saaidi

Facilities and Construction Project Management Department, International College of Engineering and
Management, Muscat, Oman

Email: azza@icem.edu.om

ORCID: 0009-0000-6216-4834

Sheikha Al Shekaili

Facilities and Construction Project Management Department, International College of Engineering and
Management, Muscat, Oman

Email: sheikha@icem.edu.om

Page | 20

Abstract

Agricultural residue valorization offers opportunities to connect resource efficiency, local enterprise, and cultural heritage. This study examined community perspectives on the economic, environmental, and cultural value of palm-frond utilization in Oman and barriers to production and commercialization. A mixed-method study combined a purposively recruited questionnaire survey of 108 participants with face-to-face interviews involving six community members. Survey data were analyzed descriptively, and interviews were examined through content analysis. The five-item agreement scale had a Cronbach's alpha of .816 and an overall mean of 4.20 (SD = .618). Waste reduction received the highest item rating (M = 4.38). Handcrafted-product sales were the most frequently selected economic benefit (75 selections), while lower pollution was the most frequently selected environmental benefit (80 selections). Among 102 recorded challenge selections, limited public awareness (26 selections) and weak demand (24 selections) ranked highest. Interviews connected palm-frond crafts with inherited knowledge, household livelihoods, resource reuse, and the need for market and institutional support. The findings indicate favorable perceptions alongside commercialization constraints. They do not establish profitability, emissions reductions, material performance, or policy effectiveness. The study recommends producer support, product development, collection systems, and product-specific evaluation of demand, costs, and environmental performance. Its contribution is a community-informed basis for developing and evaluating palm-frond initiatives within Oman's wider sustainability agenda.

Keywords: Palm Fronds, Date-Palm Residues, Sustainable Innovation, Circular Economy, Community Perspectives, Oman, Heritage Crafts

Research Highlights

- The study combines a survey of 108 participants with six interviews to examine community perspectives on palm-frond utilization in Oman.
- Participants rated waste reduction most favorably, while handcrafted-product sales and lower pollution were the most frequently selected economic and environmental benefits.
- Limited public awareness and weak market demand ranked highest among the 102 recorded challenge selections.
- Interview accounts connected palm-frond reuse with inherited craft knowledge, household livelihoods, and needs for market and institutional support.
- The findings inform product-specific pilot initiatives; they do not establish profitability, emissions reductions, or material performance.

Page | 21

1. Introduction

1.1. Background, Research Gap and Rationale

Agricultural residues can become resources when collection, processing, product development, and markets make reuse practical. Date-palm fronds have particular relevance in Oman because they connect agricultural activity with traditional household products, craft knowledge, and possible material applications. Their availability creates an opportunity, but it does not establish that every proposed use is affordable, safe, or environmentally preferable. Understanding community perspectives is one part of assessing that opportunity.

The literature identifies several possible applications for date-palm residues. Jonoobi et al. (2019) review their properties and uses, including traditional products and potential industrial applications. Bamaga (2022) examines date-palm fibers in concrete and mortar, while Dhakal et al. (2024) discuss their use as reinforcement in biocomposites. These studies provide a technical basis for considering utilization, although performance varies with the material, processing route, and intended application.

Palm-frond use also has a cultural dimension. Almamari et al. (2020) examine relationships between Omani crafts and identity. UNESCO's (2022) inscription of date-palm knowledge, skills, traditions, and practices, including Oman, recognizes the broader heritage associated with the tree. Craft production may therefore be understood as both a material activity and a way of sustaining knowledge. Commercial development should consider how producers participate and how skills are transmitted, alongside product demand.

The policy relevance lies in the relationship between resource management, enterprise, and national development. Oman Vision 2040 provides a national context for environmental sustainability and economic diversification (Oman Vision 2040 Implementation Follow-up Unit, 2025). The present study does not evaluate the implementation or effectiveness of the Vision. It examines community perceptions that could inform locally appropriate initiatives within that wider policy setting.

Technical research alone cannot explain whether farmers, craft producers, consumers, and other community members see value in palm-frond products or what prevents broader uptake. Conversely, favorable perceptions do not establish technical feasibility or environmental benefit. This study addresses the community dimension by combining survey responses with interview accounts. It focuses on perceived benefits, heritage meanings, and reported production and commercialization barriers.

1.2 Aim and Research Questions

The study aims to examine community perspectives on sustainable innovation through palm-frond utilization in Oman. Specifically, it seeks to describe participants' perceptions of the contribution of palm-frond reuse to sustainable innovation and circular resource use; identify the economic and environmental benefits they associate



with utilization; examine reported production and commercialization challenges; and integrate survey findings with interview accounts of heritage, livelihoods, and support needs. Its contribution is a descriptive account of these perspectives rather than a tested causal model of sustainability transitions.

Research questions:

- How do participants perceive the contribution of palm-frond recycling to sustainable innovation and circular economy practices in Oman?
- What economic and environmental benefits do they associate with utilization?
- What challenges are reported in producing or marketing palm-frond products?

1.3 Theoretical and Conceptual Framework

The study is informed by the circular economy perspective, which emphasizes retaining material value through strategies such as reducing waste, reusing materials, and recycling. Kirchherr et al. (2023) show that circular economy conceptualizations connect resource-use practices with wider systems and stakeholder participation, while cautioning that environmental sustainability and economic development are not automatically achieved together. Applied to palm-frond utilization, this perspective directs attention to how residues may remain useful through craft production and other applications, together with the collection, processing, market, and institutional conditions required. It provides an interpretive foundation rather than a theory tested statistically in this study. Conceptually, the study considers material reuse, livelihood opportunities, and cultural continuity as related dimensions of sustainable innovation. It examines perceived contributions to circular resource use, perceived economic and environmental benefits, and reported production and marketing challenges. Interview accounts add heritage meanings and support needs, informed by the treatment of crafts as expressions of identity and transmitted knowledge (Almamari et al., 2020; UNESCO, 2022). The survey and interview findings are integrated descriptively, keeping community perceptions distinct from verified market outcomes, environmental effects, and material performance. No causal pathways, mediating relationships, or statistical predictions are proposed.

2. Literature Review

2.1 Palm-frond utilization and circular resource use

Palm fronds are the leaves of a palm tree. This study concerns date-palm materials and their associated practices in Oman. Date palm should be distinguished from oil palm, which produces different agricultural and industrial residue streams. Evidence on oil-palm waste cannot be transferred directly to Omani date-palm applications without attention to species, material composition, processing, and local conditions. Jonoobi et al. (2019) identify a range of applications for date-palm components, while Dhakal et al. (2024) review opportunities and property enhancement in fiber composites. Together, these sources support considering residues as materials with application-specific characteristics. Reuse becomes relevant to circular resource use when it retains material value and avoids unnecessary disposal. Its environmental advantage must still be assessed against collection, treatment, manufacturing, service life, and end-of-life requirements. Figure 1 illustrates the palm fronds considered in this study and provides context for the material applications discussed below.



Figure 1. Palm fronds (original photograph by the author)

Figure 1 shows palm fronds, the raw material considered in this study. These leaves can be reused in handicrafts, decorative products, and selected building applications. Their utilization offers opportunities to reduce agricultural waste, support local livelihoods, and preserve traditional Omani craftsmanship.

2.2 Construction and design applications

Date-palm fibers have been investigated in cement-based and other composite materials. Althoey et al. (2022) examine the behavior of concrete containing date-palm fibers, and Bamaga (2022) reviews their inclusion in concrete and mortar. These publications establish a field of material testing, not a general assurance that untreated fronds can replace conventional construction materials. Product suitability depends on the required mechanical, moisture, fire, durability, and service conditions.

Research also addresses thermal performance. Kethiri et al. (2024) examine date-palm powder in gypsum mortars, while Belhous et al. (2023) study the thermal behavior of a residential building using a date-palm-fiber-based material in Morocco. These settings differ from Omani buildings. Their relevance is to identify potential applications requiring local assessment, rather than infer measured energy savings or emissions reductions from the current survey.

Decorative design provides another application pathway. Al-Saud et al. (2024) investigate recycled palm waste in design applications for tourist destinations. Such work supports considering design and use context together. For Omani enterprises, demand, finishing, consistency, safety, pricing, and access to customers would require assessment before production could be scaled.

2.3 Heritage, livelihoods, and community participation

Traditional crafts carry meanings that extend beyond the sale of objects. Almamari et al. (2020) connect craft identity with Omani places and landscapes, and UNESCO (2022) recognizes the transmission of date-palm knowledge and practices across generations. This perspective helps explain why participants may value palm-frond products even when they are not involved in their production. Heritage recognition, however, does not automatically create a stable market.

Figures 2 and 3 illustrate traditional craft applications of date-palm leaves. These examples demonstrate product forms and weaving practices rather than sales performance or consumer demand.



Figure 2. Traditional hat made from date-palm leaves. Source: Alzeedi Pottery, Instagram, 2021.

Figure 2 shows a traditional hat woven from date-palm leaves, illustrating their use in functional handicrafts. It highlights the potential of palm-frond utilization to preserve traditional skills, support local craft livelihoods, and promote the reuse of natural materials.



Figure 3. Traditional mat and basket made from date-palm leaves. Source: Alzeedi Pottery, Instagram, 2021.

Figure 3 shows a traditional mat and basket woven from date-palm leaves. These products illustrate how palm fronds can be transformed into useful household and decorative items while preserving traditional craftsmanship. Their production also offers opportunities for local income generation and sustainable resource use.

3. Methodology

3.1 Design and participants

A mixed-method research design combined a questionnaire survey with face-to-face interviews. The quantitative sample comprised 108 purposively selected participants from community and occupational groups relevant to palm-frond utilization, including farming, crafts, engineering, business, education, and other roles. Respondents included both work-related users and non-users of palm fronds. The survey therefore captures practitioner experience alongside wider community perspectives.

The qualitative component involved six community members with practical knowledge of palm-frond activities, identified in the study's methods as four farmers and two architects. The interviews complemented the survey by exploring heritage meanings, perceived benefits, and production and marketing concerns. The sample was selected for its relevance to these issues rather than to represent the Omani population.

3.2 Questionnaire and reliability

The questionnaire included a five-item agreement scale scored from 1 (strongly disagree) to 5 (strongly agree), together with multiple-response questions on economic benefits, environmental benefits, and challenges. Six experts from Omani universities reviewed the questionnaire for clarity and relevance. Revisions included rewording, removing, and adding statements. The research records describe panel approval exceeding 80%; this is treated as an expert-review outcome rather than a calculated item-level content-validity index.

Table 2 reports internal consistency for the agreement scale. Cronbach's alpha was not applied to the multiple-response checklists because their options represent distinct benefits or challenges rather than interchangeable indicators of one latent construct. Alpha should be interpreted in relation to the intended scale and does not alone establish validity or unidimensionality (Taber, 2018). Results are presented numerically without assigning "high" or "very high" categories, avoiding reliance on unspecified classification thresholds.

3.3 Interviews and analysis

Four open-ended interview questions addressed cultural and heritage values, economic and environmental benefits, sustainable innovation, and challenges in using or marketing palm-frond products. Content analysis involved comparing responses and identifying recurring elements, which were organized into four themes. Participant identifiers P1–P6 preserve attribution while protecting identities. The analysis is presented as a descriptive interpretation of the available interview accounts; it does not claim saturation, independent coding agreement, or translation validation.

Survey data were analyzed descriptively in SPSS using frequencies, means, and standard deviations. No inferential hypothesis testing was undertaken. For multiple-response questions, a percentage of participants differs from a percentage of recorded selections. Tables 4 and 5 present both measures using the full survey base of 108 and their respective selection totals. Because a valid respondent denominator cannot be established for the challenges question, Table 6 reports frequencies and each option's share of the 102 recorded selections. These shares describe the response distribution and are not estimates of the proportion of participants experiencing a challenge.

Percentages were recalculated from the reported frequencies and rounded to whole numbers. In Table 1, the listed occupational categories account for 101 records and the listed locations for 107, against the stated survey total of 108. Residual rows make the seven occupational records and one location record not allocated in the available summaries explicit; they do not assign characteristics to these participants or establish why the records were unallocated. Location labels are retained as reported places rather than interpreted as comparable governorates. Survey and interview findings are integrated descriptively.

3.4 Ethical considerations

Participants were informed about the research purpose, the voluntary nature of participation, and their right to withdraw without negative consequences. Anonymity and confidentiality were maintained during analysis and reporting, and interview participants are identified only by codes. Institutional approval documentation, the form of consent, and data-retention procedures were not available for assessment; no unverified approval or exemption is asserted.



4. Findings and Discussion

4.1 Participant characteristics

Table 1 presents the available occupational and location categories and work-related use of palm fronds. Residual rows account explicitly for records not allocated to categories in the available summaries. All percentages use the stated sample of 108 and are rounded to whole numbers.

Page | 26

Table 1. Reported characteristics of survey participants

Characteristic	Frequency	% of 108
Occupation		
Farmer	22	20
Academic Lecturer	7	6
Business Sector	3	3
Engineering	6	6
Eco Business Sector	6	6
Artisan	8	7
Employee	8	7
Medical Sector	7	6
Not Employee	2	2
Student	9	8
Community Member	23	21
Not allocated in available occupational summary	7	6
Reported location		
Muscat	36	33
Al Buraimi	11	10
Al Seeb	2	2
Al Sharqiyah	6	6
Al Amerat	4	4
Barkaa	12	11
Al Dakhiliyah	4	4
others	32	30
Not allocated in available location summary	1	1
Uses palm fronds at work		
Yes	34	31
No	74	69

Note. N = 108. Residual rows are arithmetic differences between the stated sample and listed category totals, not newly assigned participant characteristics. Location names represent mixed administrative levels and are retained as reported places. Rounded percentages may not sum to 100%.

As shown in Table 1, community members (23; 21%) and farmers (22; 20%) were the largest reported occupational categories. Muscat was the most frequently reported place (36; 33%). Thirty-four participants (31%) used palm fronds at work, while 74 (69%) did not. Seven occupational records and one location record were not allocated in the available category summaries. These gaps restrict detailed subgroup interpretation but do not change the stated survey sample. The findings primarily describe a purposively recruited mixture of practitioners and other community members.

Table 2 summarizes the reported reliability of the five-item agreement scale.

Table 2. Internal consistency of the agreement scale

Scale	Items	Cronbach's α
Sustainable innovation and circular economy agreement scale	5	.816

In Table 2, the reported alpha of .816 suggests internal consistency among the five items in this sample. It does not establish that perceived environmental benefit, expected income, and support for public intervention are identical concepts. The items should therefore also be interpreted individually. The distinction is important because the final item expresses a preference for authority support rather than an observed outcome of recycling (Taber, 2018).

4.2 Perceived contribution to sustainable innovation

Table 3 presents agreement with the five statements and the overall scale summary. Item means are emphasized because the scale includes both perceived benefits and a preference for local-authority support.

Table 3. Agreement with palm-frond utilization statements

Statement	Mean	SD
Using palm fronds reduces production costs	3.82	.905
Recycling palm leaves creates income opportunities	4.24	.830
Palm frond reuse helps reduce farming waste in the community	4.38	.840
Using palm fronds contributes to environmental protection	4.24	.916
Local authorities should support the use of palm fronds	4.36	.814
Overall reported scale	4.20	.618

Note. Five-point agreement scale: 1 = strongly disagree and 5 = strongly agree. The overall mean and SD are the reported composite summaries. The rounded item means also average 4.20; the composite SD cannot be reconstructed from item SDs alone.

As shown in Table 3, the overall reported mean was 4.20 (SD = .618). Reducing farming waste received the highest rating (M = 4.38), followed closely by support from local authorities (M = 4.36). Income opportunities and environmental protection each received 4.24. Reduced production costs received the lowest mean, 3.82. This suggests more favorable perceptions of waste reduction and support needs than of cost savings. The survey does not establish whether production costs actually fell.

The pattern is compatible with the material opportunities identified in date-palm research (Jonoobi et al., 2019; Dhakal et al., 2024). It also highlights the need to move from perceived benefits to application-specific evaluation. Collection, preparation, treatment, labor, and quality requirements may affect whether a particular product is economically viable, even where the raw residue is locally available.

4.3 Perceived economic benefits

Table 4 reports the economic options selected by survey respondents. The two percentage columns distinguish the proportion of participants from the share of all 338 selections.

Table 4. Perceived economic benefits of utilization

Benefit	Selections	% of 108	% of 338 selections
Income through handcrafted-product sales	75	69	22
Support for traditional and home-based industries	74	69	22
Employment for local community members	73	68	22
Lower material costs	65	60	19
Added value for agricultural by-products	51	47	15

Note. Multiple answers were allowed. Respondent percentages exceed 100% in total because participants could select several options. Percentages were recalculated from the reported counts.

In Table 4, handcrafted-product sales ranked first, selected by 75 participants (69%), followed by support for traditional and home-based industries (74; 69%) and employment (73; 68%). Added value for agricultural by-products was selected less often (51; 47%). These responses show which opportunities participants recognized; they do not quantify income or employment generated. The prominence of craft livelihoods fits the cultural and place-based dimensions of Omani craft production discussed by Almamari et al. (2020).

4.4 Perceived environmental benefits

Table 5 presents environmental options using the same 108-person survey base and a total of 343 selections.

Table 5. Perceived environmental benefits of utilization

Benefit	Selections	% of 108	% of 343 selections
Lower pollution levels	80	74	23
Natural-resource preservation through material substitution	72	67	21
Reduced agricultural waste	69	64	20
Sustainable farming and environmentally friendly practices	67	62	20
Public awareness of environmental protection	55	51	16

Note. Multiple answers were allowed; respondent percentages need not total 100%. These are perceived benefits, not measured environmental impacts.

As shown in Table 5, lower pollution was the most frequently selected benefit (80; 74%), followed by natural-resource preservation (72; 67%) and waste reduction (69; 64%). Awareness was selected by 55 respondents (51%). The relatively lower selection of awareness does not establish that respondents lack knowledge; it indicates that fewer selected this particular benefit. Thermal and composite research identifies potential material applications (Belhous et al., 2023; Kethiri et al., 2024), but this survey cannot establish energy savings, emissions reductions, or environmental superiority in Oman.

4.5 Production and commercialization challenges

Table 6 presents the recorded challenge selections. Frequencies are reported alongside their shares of the 102 selections, allowing the distribution of reported concerns to be examined without assuming a respondent denominator.

Table 6. Reported production and commercialization challenges

Challenge	Frequency	% of 102 selections
Limited public awareness of product value	26	25
Limited market demand	24	24
Limited government or local institutional support	21	21
Low profits or product prices	19	19
Inconsistent access to raw materials	12	12

Note. Multiple answers were permitted. Percentages are calculated as frequency ÷ 102 selections × 100 and rounded to whole numbers. They describe shares of selections, not percentages of respondents; their rounded total is 101%. The valid number of respondents to this question is unavailable.

In Table 6, limited public awareness accounted for 26 of the 102 selections (25%), followed by limited market demand (24; 24%), insufficient institutional support (21; 21%), low profits or prices (19; 19%), and inconsistent raw-material access (12; 12%). This distribution identifies the relative prominence of concerns in the recorded answers. It cannot establish how widespread these concerns were among all 108 participants or the 34 work-related users. Technical barriers also remain relevant because materials research identifies processing and performance requirements that a perception survey cannot evaluate (Bamaga, 2022; Althoey et al., 2022).

4.6 Interview findings

Table 7 presents the four themes identified through descriptive content analysis and illustrative excerpts from the interview accounts. English wording and participant identifiers are retained from the research manuscript. These excerpts convey individual perspectives rather than prevalence estimates for the wider community.

Table 7. Themes and illustrative interview excerpts

Theme	Description	Illustrative excerpt
Heritage and continuity	Palm-frond practices are associated with earlier housing and family knowledge.	"These crafts remind us of the way our grandparents lived in the past" (P5).
Innovation and reuse	Participants envisaged processing residues into new products and livelihoods.	"...For example, in the future, a factory could be established to manage palm waste, where it would be processed, reproduced, and reused." (P2; excerpt).
Economic and environmental value	Accounts connected locally available materials with income, costs, and waste reduction.	"...It also provides income for artisans and reduces costs when used in construction, as the resources are readily available within Oman." (P2).
Support and skills development	Participants called for institutional support and education about crafts.	"....The traditional handicrafts art must be included in schools' curriculums..." (P4).

Note. P1–P6 identify interview participants. Quotations retain the English wording in the supplied research manuscript; ellipses indicate excerpts. Theme descriptions summarize recurring ideas and are not counts of agreement.

As shown in Table 7, heritage meanings connect utilization with family history and earlier building practices. P1 described ventilation and shade provided by palm materials, while P5 associated crafts with grandparents' lives. These recollections help explain cultural value but do not constitute measurements of thermal performance. The theme is consistent with heritage research that treats crafts as expressions of place and identity (Almamari et al., 2020; UNESCO, 2022).

The innovation theme concerned possibilities rather than existing investments. P2 proposed a future processing factory and opportunities for unemployed young people. This illustrates an aspiration to extend reuse beyond established craft activities. The proposal requires assessment of feedstock, processing, safety, costs, customers,

and environmental performance before it can support an investment decision. Unverified accounts of specific institutional technologies are excluded from the interpretation. Interview accounts also described household livelihood opportunities, including women's roles in producing and distributing heritage products. No participant-level prevalence count is assigned to this observation because the available narrative does not support consistent attribution across all accounts. Participants called for government assistance, clearer procedures, and craft education. These views complement the survey's market and support concerns without establishing a specific policy failure or implying unanimous agreement.

4.7 Integration of survey and interview findings

Table 8 brings the two strands together at the level supported by the available evidence. It distinguishes convergent perceptions from conclusions requiring further investigation.

Table 8. Descriptive integration of the two data strands

Area	Description	Interpretive boundary
Livelihoods	Survey selections emphasized craft sales, home industries, and jobs; interviews described artisan and household income.	Income and employment were anticipated or reported in accounts, not measured through financial records.
Resource reuse	Survey agreement emphasized waste reduction; interviews valued reuse and local availability.	No waste audit, life-cycle assessment, or comparative material test was conducted.
Heritage	Interviews connected products with family knowledge and older housing practices.	Heritage significance was not measured using a dedicated survey scale.
Commercialization	Survey challenges and interviews both highlighted demand, awareness, and support.	Challenges are reported as shares of selections; policy effectiveness was not evaluated.

As shown in Table 8, both strands support a community narrative in which reuse is valued but commercialization requires enabling conditions. The interviews add cultural meanings and practical concerns that the checklists cannot explain fully. This integration strengthens contextual interpretation; it does not convert perceived benefits into measured outcomes. No causal relationships or statistically significant group differences were tested.

5. Implications of Findings

The study suggests that producer support should combine skills, product development, and market access. Demonstration projects could test specific products with clearly identified users, prices, and quality requirements. Partnerships with craft producers should recognize their design knowledge and avoid treating heritage merely as a marketing label. Al-Saud et al. (2024) provide a related decorative-design context, while Oman's heritage literature emphasizes the local meanings that should be maintained (Almamari et al., 2020).

For construction uses, quality and safety assessment should precede market promotion. Consistent feedstock preparation, moisture behavior, mechanical performance, fire response, durability, and maintenance should be assessed for the intended use. Date-palm-fiber studies identify a basis for such investigations (Bamaga, 2022; Dhakal et al., 2024). Locally available residues alone do not establish compliance with building requirements or lower whole-life costs.

5.1 Limitations and Interpretation

Limitations include purposive sampling, a six-person interview sample, and incomplete documentation of recruitment, fieldwork dates, and overlap between the two strands. Some demographic records are not allocated in the available summaries, and reported place names represent mixed administrative levels. Challenge results are therefore interpreted as shares of recorded selections because the valid respondent base is unavailable. Internal consistency is available for only one scale, and the qualitative material does not permit independent assessment of coding, translation, or saturation. No financial audit, emissions assessment, waste measurement, material test, or



policy evaluation was conducted. Findings describe participating community perspectives and do not establish population prevalence or economic and environmental effects.

6. Conclusion

Participants perceived palm-frond utilization as an opportunity to reduce waste, support livelihoods, and sustain cultural knowledge. The survey emphasized waste reduction, craft income, and public support, while interviews connected reuse with heritage and commercialization needs. Limited awareness and weak demand were the most frequently selected challenges. These rankings identify priorities in the recorded responses rather than the prevalence of difficulties across the full sample.

The findings support further development and evaluation of locally appropriate palm-frond products rather than claims of demonstrated economic or environmental effectiveness.

Page | 31

7. Recommendations

Priorities are to strengthen producer capability, test demand, improve collection and preparation where justified, and assess quality and safety for each application. Aligning initiatives with national sustainability objectives requires measurable outputs and outcomes, not favorable attitudes alone.

Collection and preprocessing systems may help connect agricultural residues with producers, but their design should follow local evidence on quantities, seasonality, transport, storage, and costs. Business support could focus on costed prototypes and customer testing rather than assume that awareness campaigns will create demand. Public support should have explicit objectives and monitored outcomes. These are recommendations arising from the perceptions documented here, not interventions evaluated by the study.

Future research should separate users, producers, consumers, and decision-makers in sampling and analysis; document valid denominators; and examine specific value chains. Larger comparative studies could test how perceptions differ across roles and locations. Product-specific pilot studies should combine financial, environmental, and technical assessment with producer and consumer feedback. Longitudinal work could then evaluate whether support programs lead to sustained production and viable sales.

Acknowledgements

The authors thank the participants, the International College of Engineering and Management, and the Ministry of Higher Education, Research and Innovation for their support under project reference MOHERI/BFP/ICEM/2024/2.

Funding

The study acknowledges support from the Ministry of Higher Education, Research and Innovation and the International College of Engineering and Management under project reference MOHERI/BFP/ICEM/2024/2. No statement about the funder's involvement in research decisions is made because that information is not documented in the available materials.

CRedit Authorship Contribution Statement

Saada Al Habsi, Azza Al Saaidi, and Sheikha Al Shekaili are the named authors. Individual CRedit roles require confirmation by the authors before submission.

Ethical Statement

Participants received information about the study and their withdrawal rights, and participation was voluntary. Anonymity and confidentiality were maintained. Institutional ethics approval or an applicable exemption must be documented by the authors before submission; no approval reference has been inferred.



Declaration of Interests

The authors declare no conflicts of interest.

Data Availability

The study includes survey responses and interview material requiring protection of participant confidentiality. A verified data-access arrangement was not provided. Requests concerning data availability should be directed to the corresponding author; access must follow the original consent conditions and applicable institutional requirements.

Page | 32

AI Usage

AI assistance was used for language refinement, organization, formatting, reference verification, and arithmetic checks of reported summaries. No participant responses or interview quotations were generated. The authors retain responsibility for reviewing and approving the final manuscript, its supporting evidence, and this disclosure.

References

- Almamari, B., Al-Yahyai, F., & Al-Amri, M. (2020). Traditional Omani crafts approaches to identity. *Technium Social Sciences Journal*, 10(1), 566–578. <https://doi.org/10.47577/tssj.v10i1.1328>
- Al-Saud, K. M., AlAli, R., Abouelela, A. S., & Al Saud, A. M. (2024). Exploring the feasibility for utilizing recycled palm waste in decorative design applications as enhancements for tourist destinations: A step toward environmental sustainability. *Sustainability*, 16(3), Article 1003. <https://doi.org/10.3390/su16031003>
- Althoey, F., Hakeem, I. Y., Hosen, M. A., Qaidi, S., Isleem, H. F., Hadidi, H., Shahapurkar, K., Ahmad, J., & Ali, E. (2022). Behavior of concrete reinforced with date palm fibers. *Materials*, 15(22), Article 7923. <https://doi.org/10.3390/ma15227923>
- Bamaga, S. O. (2022). A review on the utilization of date palm fibers as inclusion in concrete and mortar. *Fibers*, 10(4), Article 35. <https://doi.org/10.3390/fib10040035>
- Belhous, M., Boumhaout, M., Oukach, S., & Hamdi, H. (2023). Effect of a material based on date palm fibers on the thermal behavior of a residential building in the Atlantic climate of Morocco. *Sustainability*, 15(7), Article 6314. <https://doi.org/10.3390/su15076314>
- Dhakal, H. N., Khan, S. H., Alnaser, I. A., Karim, M. R., Saifullah, A., & Zhang, Z. (2024). Potential of date palm fibers (DPFs) as a sustainable reinforcement for bio-composites and its property enhancement for key applications: A review. *Macromolecular Materials and Engineering*, 309(10), Article 2400081. <https://doi.org/10.1002/mame.202400081>
- Jonoobi, M., Shafie, M., Shirmohammadli, Y., Ashori, A., Zarea-Hosseiniabadi, H., & Mekonnen, T. (2019). A review on date palm tree: Properties, characterization and its potential applications. *Journal of Renewable Materials*, 7(11), 1055–1075. <https://doi.org/10.32604/jrm.2019.08188>
- Kethiri, M. A., Belghar, N., Chikhi, M., Bouter, Y., Beldjani, C., & Tedeschi, C. (2024). Experimental study on the effect of date palm powder on the thermal and physico-mechanical properties of gypsum mortars. *Sustainability*, 16(7), Article 3015. <https://doi.org/10.3390/su16073015>
- Kirchherr, J., Yang, N.-H. N., Schulze-Spüntrup, F., Heerink, M. J., & Hartley, K. (2023). Conceptualizing the circular economy (revisited): An analysis of 221 definitions. *Resources, Conservation and Recycling*, 194, Article 107001. <https://doi.org/10.1016/j.resconrec.2023.107001>
- Oman Vision 2040 Implementation Follow-up Unit. (2025). Oman Vision 2040 report 2024–2025. <https://www.oman2040.om/OV2040Report2024-2025?lang=en>
- Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48(6), 1273–1296. <https://doi.org/10.1007/s11165-016-9602-2>
- UNESCO. (2022). Date palm, knowledge, skills, traditions and practices. <https://ich.unesco.org/en/RL/date-palm-knowledge-skills-traditions-and-practices-01902>

