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Original Research

Sustainable Pens from 100% Recycled Manufacturing Scrap: A First-of-Its-Kind Product for Pakistan

Feasibility, Market Demand, Environmental Impact, and Consumer Research

Pakistan Market Case Study, 2025–2026

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Abstract

Pakistan consumes an estimated 500 million disposable pens annually, generating roughly 2,300 tonnes of unrecovered plastic waste. No domestic manufacturer currently produces a pen made from zero virgin plastic. Biodegradable pen alternatives, though growing globally, are commercially non-viable in Pakistan because the binding agents required for their manufacture are not available in the country. This paper presents the case for a pen that is feasible and sustainable. A ballpoint pen made from plastic scrap generated during the manufacturing and moulding processes, with zero virgin plastic content. Primary research conducted in May 2026 surveyed 54 respondents, predominantly students aged 15–18 based in Lahore (a non-random convenience sample). Among this sample, 79.6% stated they would be interested in using sustainable recycled-plastic pens, and 66.6% stated a willingness to pay Rs. 100 or more per pen, and 94.4% indicated they would expect to buy from stationery shops. These are stated preferences rather than observed purchases, so they indicate potential demand and a likely retail channel among young urban students, not proven commercial viability. The paper argues that this pen occupies a market position that no existing domestic product holds, and that rising sustainability awareness among urban youth makes it a promising candidate for further market testing, including a pilot launch, across a broader and more representative sample of Pakistani consumers.

Keywords: Sustainability; Net Zero Plastic; Environmental Impact Analysis; Willingness To Pay

1. Introduction

1.1 Background: Pakistan's Plastic Pollution Crisis and the Pen Industry's Hidden Contribution

Pakistan produces approximately 20 million tonnes of solid waste every year. Around 20 percent of this comes from plastics, amounting to around four million tonnes every year, 5–7 percent of which gets officially recycled in Pakistan, according to UNEP. The rest of the plastic waste goes to open landfills, clogs drains, pollutes agricultural land, and enters the Arabian Sea via the Indus River. In addition to being one of the ten countries contributing most to plastic pollution of the oceans, Pakistan faces serious consequences for fisheries and human health.

In terms of plastic waste production, however, the issue of stationery products is often overlooked, although both its extent and significance are undeniable. There are 50 million school-going children and

millions of office employees using various writing tools in Pakistan. The total number of inhabitants is 230 million people who have to purchase stationery. Pen use in Pakistan can be estimated at 500 million units a year. On average, a ballpoint pen barrel consists of around 4.6 grams of plastic—mostly of virgin polystyrene or ABS. Thus, a minimum of 2,300 tonnes of plastic enters the consumption chain via pens each year with zero recycling rate. The problem lies in the design of the conventional ballpoint pen itself. It belongs to the linear economy: resins made from petrochemicals get extruded or injection moulded into barrels; filled with ink, these barrels become ballpoint pens and get thrown away when the ink is exhausted. This results in mixed materials consisting of plastic, metal spring, ballpoint tip, and dried ink getting thrown away and not even noticed by the market-oriented informal sector in Pakistan. Pen parts cannot be processed due to their scrap value and the complexity of separation.

1.2 Why Biodegradable Pens Are Not the Answer in Pakistan

When it comes to sustainable pens internationally, there are two streams of materials that dominate this topic. The first one includes biodegradable pens made out of cornstarch bioplastics, bamboo, or seed paper. The other includes recycled-material pens—pens made out of post-consumer or post-industrial plastic. However, despite the fact that the production of biodegradable pens has gained popularity across Europe, North America, and some areas of India, it is impossible for Pakistan to follow this lead. Namely, the agents needed for producing cornstarch bioplastic pen barrels, which would ensure sufficient rigidity of the biodegradable polymer to make injection molding possible, include compatibilizers and plasticizers. Unfortunately, these chemicals are not present in the local industrial infrastructure and, therefore, cannot be bought even in the small quantities needed for the production of sustainable pens due to high prices and difficult logistics. Thus, every single biodegradable pen produced in Pakistan must currently be imported from other countries; hence, the price tag attached to each of these items is extremely high. In the long run, Pakistan can hardly bridge the gap between its current industrial capacity and necessary for producing sustainable resources. Consequently, when an entrepreneur seeks to start producing a sustainable pen in Pakistan right now, this person faces only one choice—recycled pens.

1.3 Why No Zero-Virgin-Plastic Pen Exists in Pakistan

Beyond biodegradables, one might ask: why does no Pakistani manufacturer currently produce a pen from recycled plastic? The answer lies in both the supply chain and commercial incentives. Virgin polystyrene and ABS resin, purchased from commodity petrochemical suppliers, are inexpensive, consistent in quality, and available at scale. Recycled plastic granulate, whether post-consumer (from collected waste) or post-industrial (from manufacturing scrap), requires a separate sourcing infrastructure, involves variable quality that demands additional quality control, and at small volumes costs more per kilogram than virgin resin. Conventional pen manufacturers operating on thin margins in a price-competitive commodity market have no commercial incentive to switch. The result is that, as of 2026, no pen sold or manufactured in Pakistan contains zero virgin plastic. Imported eco-pens from European or American brands are available in small quantities in premium Karachi and Lahore outlets at Rs. 200–500, but these are foreign products, not domestically produced, and they remain inaccessible to the overwhelming majority of Pakistani consumers.

1.4 The First-of-Its-Kind Proposition

This case study documents the development of a pen that is the first of its kind in Pakistan: a ballpoint pen manufactured entirely from plastic scrap generated during the injection moulding and manufacturing process itself, post-industrial recycled plastic, with zero virgin plastic content in the barrel or cap. The elegance of the source lies in its simplicity. Any injection molding process results in scrap in the form of runners (the conduits through which plastic resin enters the mold from melting), sprues (which serve as the point of entry into the mold), flash (excess resin produced at the edges of the mold parts), and faulty parts that do not meet quality standards. Traditionally, such scrap is reground and added to virgin resin, or scrapped completely. In the present pen-making model, such scrap serves as the raw material

for both the barrel and cap. Virgin resin is not needed for making the barrel or cap at all. No consumer waste gathering is required. The recyclable scrap comes directly out of the manufacturing process and forms a self-contained loop of scrap utilization. The beauty of this method is that it tackles the two major obstacles that have made a recycling-based business model impossible until now: lack of post-consumer waste management facilities and the inability to match the costs of virgin resin-based mass production.

1.5 Research Questions

The purpose of this case study is to clarify what is commercially feasible; to establish the receptiveness of consumers; to define the design requirements for the pen; and to assess its environmental impact through analysis of surveys from 54 respondents across Pakistan in May of 2026.

Research Questions:

1. Are consumers in Pakistan willing to purchase pens made with 100% recycled plastic?
2. What factors impact the decision to purchase or not purchase sustainable stationery?/What is the acceptable price point for a zero-virgin/plastic pen to be commercially viable in the Pakistani marketplace?
3. What level of awareness do consumers have regarding plastic pollution, and does this affect their purchase intent?
4. What design elements, features, and marketing channels would be used to develop the pen?/How much environmental benefit can be achieved through the mass-scale distribution of the pen?

The case study was developed using six objectives that address the commercial, environmental, and operational aspects of the pen.

Objective 1: Establish a baseline of awareness regarding plastic pollution to consumers, particularly students as the primary target market.

Objective 2: Understand buying habits, including how frequently they purchase, how many pens consumers buy each time, what type of pen consumers purchase, and how they purchase it.

Objective 3: Determine what consumers consider an acceptable price for a recycled pen and identify the things that could increase the acceptable price of a recycled pen, such as warranties, environmental claims, and branding.

Objective 4: Establish, in the existing competitive structure of the stationery market in Pakistan, what the position of the proposed pen is and what the competitive threats are.

Objective 5: Identify scaling pathways. To determine the institutional, geographic, and channel-based opportunities available for growing the business beyond its initial launch phase, with reference to the distribution and channel preferences identified in the survey.

Objective 6: Quantify environmental impact. To project, using life-cycle assessment methodology, the GHG emissions savings and plastic waste reduction achievable.

2. Literature Review

2.1 Sustainability and Consumer Behaviour

The academic literature on sustainable consumption identifies a persistent and well-documented "attitude-behaviour gap", the phenomenon whereby consumers express strong environmental intentions in surveys yet revert to conventional choices at the point of purchase. Kollmuss and Agyeman (2002) identified the structural causes: habit, convenience, price anchors, social norms, and the psychological tendency to discount diffuse or future harms relative to immediate, tangible costs. This gap is well established across product categories from food to fashion to consumer electronics. In the stationery category, however, the gap may be structurally narrower than in most others, for two reasons. First, the switching cost is extremely low; choosing a recycled-plastic pen involves no behavioural change, no lifestyle adjustment, no dietary modification. The pen is used identically. Second, the price differential at the proposed price point (Rs. 80–120 versus Rs. 20–30 for a commodity pen) is modest in absolute terms for students and professionals who already buy mid-tier pens. The primary barrier is not the gap between values and action, but the simpler matter of product availability and awareness.

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Survey data from the present study are consistent with this interpretation, though they cannot confirm it. When asked directly whether they would be interested in using pens made from 100% recycled plastic, 79.6% of respondents said yes, 16.7% said maybe, and only 3.7% said no. Because these are stated intentions rather than observed purchases, they do not measure the attitude-behaviour gap itself; the gap may well reappear at the point of sale. What the responses do suggest is that, within this sample, there is little outright resistance to the concept, so the marketing challenge may be one of reaching and converting receptive consumers rather than persuading sceptics. This remains a hypothesis to be tested through trial or pilot sales. Research on Gen Z consumers (born 1997–2012), who constitute the dominant age group in this survey, consistently finds elevated sustainability values relative to prior generations. Deloitte's 2023 Global Millennial Survey found that Gen Z consumers are more likely to make purchasing decisions based on environmental and social impact than any preceding cohort, and more likely to advocate for sustainable brands through social media. The social identity function of sustainable consumption (buying sustainable products as a way of signalling values to peers) is particularly salient for this demographic, and has direct implications for the pen's design and marketing: the pen must be an object that Gen Z students are proud to be seen using.

2.2 Plastic Waste in Pakistan: The Structural Problem

Pakistan ranks among the top ten contributors to global mismanaged plastic waste. UNEP estimates that 93% of the country's plastic waste is inadequately managed, ending in open dumps, being burned in open air, or being discharged into waterways. The Indus River system serves as the main conduit for plastic waste from Pakistan's interior to the ocean, making it one of the most plastic-polluted river systems on earth.

In Karachi, Lahore, and Faisalabad, there is an organized recycling program for waste materials, which includes separate sorting, processing, and sales of valuable recyclables by informal waste collectors called kabari dealers. Some of those valuable recyclables are PET and HDPE containers, metals, and cardboard, all of which will have established markets or resale values. However, recycled polystyrene and ABS plastic sold as a material used to manufacture pens will not have established markets for resale due to their low value as scrap, contamination due to mixed materials from their use in writing instruments, and no collection system to specifically collect them. Government regulatory policies have been gradually tightening and moving towards more restrictions on single-use plastics, such as the 2019 Single-Use Plastic Ban in Islamabad and the subsequent ban in Khyber Pakhtunkhwa and parts of Sindh. There are currently extended producer responsibility programs being developed; however, none of the current regulations apply to manufacturers in the stationery industry. While there are no applicable current regulations for the stationery manufacturing sector, the future direction of regulatory policy indicates that there will be more stringent regulations against the use of single-use virgin-plastic products. Therefore, a business that uses recycled plastic to manufacture pens will be in a good position to capitalize on the need for recycled plastic pens prior to the advent of mandatory regulation.

2.3 The Global Sustainable Stationery Market and Why Pakistan Has Been Left Behind

The sustainable stationery market globally is valued at almost USD 4.2 billion in 2023. By 2030, it will grow to be worth USD 7.8 billion, at a compound growth rate of 9.2% annually. The brands that have proven this include Pilot's Begreen range of products, BIC's Ecolutions line of products, and Onyx & Green, which show that writing with recycled-material pens can perform equally to non-recycled options, while offering significant environmental benefits at a cost-effective pricing structure. Though India has seen early movers in sustainable stationery (i.e., ITC's Classmate and Cello) with their experimentation with recycled-content lines, along with several start-ups entering into sustainable stationery with either bamboo or recycled papers, there has been no local market for these products in Pakistan, primarily due to the constraints outlined in section 1.2. These constraints are structural in nature, including the local unavailability of biodegradable materials and the undeveloped supply chain for recycled plastics. This analysis product will directly address and alleviate these constraints.

2.4 Post-Industrial Recycled Plastic: The Manufacturing Scrap Model

In many industries such as automotives, electronics, and packaging, the use of post-industrial recycled (PIR) plastics has been a well-established and commercially proven strategy that reuses scrap created in the production process instead of collecting this material from consumers' waste streams. In the context of establishing a startup, there are multiple benefits to using PIR plastic over post-consumer recycled (PCR) plastic. Some of these benefits are:

1. Quality Consistency: Post-industrial scrap from an individual manufacturing process will have all of the same homogeneous material types, colours, and contamination profiles. Conversely, post-consumer plastics that are collected from consumers' waste streams will consist of many different polymer types, colours, and sources of contamination; greater processing will be needed to sort, clean, and regain temperature properties for injection molding. Though a company produces pens using polystyrene or ABS, the same formulation of material has been used from the beginning of the manufacturing process in the facility. Therefore, polystyrene or ABS scrap is able to be evaluated again and placed in the same molding machines after just going through minimal processing.

2. No Collection Infrastructure: Post-consumer plastics require a supply chain of waste collection, aggregation, sorting, and transportation; the majority of post-industrial scrap is already being produced at the point of product manufacturing. Therefore, there is no need for establishing or relying on an entirely new recycling infrastructure to produce sustainable pens.

3. Verified Material Origin: PIR plastic from a known source can be certified under the Global Recycled Standard (GRS) as genuinely recycled content with a clear and auditable chain of custody, providing the third-party verification that underpins credible environmental claims.

The pen described in this case study uses 100% PIR plastic for its barrel and cap: every gram of material in the structural components of the pen is scrap from the moulding process itself, with zero virgin resin added. This is not an aspiration or a target; it is the production model. It is also unprecedented in Pakistan's stationery manufacturing sector and offers a sustainable, clean alternative to traditional pen making, usage, and high plastic consumption patterns.

2.5 Green Marketing and the Communication of Environmental Claims

According to research on green marketing, consumers are more likely to believe claims about the environmental impact products have compared to how they feel about labels that state an item is "eco-friendly." When consumers see a product description like "made with 100% recycled content and no virgin plastics," it holds more credibility as it has an exact description of what the product is made of, can be validated, and therefore is less likely to be seen as greenwashing than a label that states "environmentally friendly." The survey data from this research study confirms the significance of branding based on a product's environmental impact: 31.5% or almost 1/3 of the respondents stated that they would be likely to purchase based on being influenced by branding based on environmental impact when asked; 61.1% of the respondents stated they would be somewhat likely to purchase based on being influenced by branding based on environmental impact. Only 7.4% of the respondents indicated that they would not be influenced whatsoever. Therefore, 92.6% of the respondents (more than 9 out of every 10 respondents) think that branding based on a product's environmental impact is at least somewhat significant to their purchasing decision. This represents an incredibly encouraging finding for environmentally based companies. In the case of low involvement purchases, like pens, the packaging is the first and most significant form of conveying environmentally related messages.

3. Methodology

3.1 Research Design

In this research, I used both quantitative and qualitative research methods. I conducted a survey using 20 questions, and the responses were collected through Google Forms. I asked people for demographic information (such as age), and we asked them what kinds of products they would buy if sustainable

products were available at a price similar to conventional products. I also used existing research on sustainable consumption behaviour and reports published by the United Nations Environment Programme and WWF-Pakistan (World Wildlife Fund). I collected data on the environmental impact of plastic pen products and the retail prices of comparable products using a combination of market research and surveys.

3.2 Sample Characteristics

The survey collected 54 complete responses. The sample is demographically concentrated: 75.9% of respondents are aged 15–18, 3.7% are under 15, 7.4% are aged 26–40, and 13.0% are 40 or older. By occupation, 83.3% are students, 7.4% are teachers, 3.7% are freelancers, 3.7% are business owners, and 1.9% are office workers. By city, 90.7% are based in Lahore, with the remainder in Islamabad, Karachi, or unspecified other cities. This concentration is both a limitation and a reflection of the intended initial target market. Students aged 15–25 in urban centres are the product's most likely first consumer segment: they are frequent pen buyers, appear sustainability-receptive, are social-media-connected, and are located in the geographic areas where the product would first be distributed. However, the findings should be read as indicating demand among a predominantly young, Lahore-based student sample, not among Pakistani consumers as a whole.

3.3 Survey Structure

The survey covered the following thematic areas: demographic identification (age, occupation, city); pen purchasing behaviour (frequency, pen type, monthly usage volume); purchase decision factors (multi-select, up to three); environmental awareness (plastic impact awareness, prior eco-purchase behaviour, sustainability importance); product concept response (interest in recycled-plastic pens, willingness to pay, readiness to pay a slight premium); product design preferences (features, colours, design styles); distribution channel preferences; and brand impact sensitivity.

3.4 Limitations of the Sample and Survey Design

Several limitations constrain how far the findings can be generalised. First, the sample is small (n = 54) and was not randomly selected. Respondents were reached through convenience channels, so self-selection is likely: people who are already interested in sustainability may have been more inclined to complete a survey about recycled pens. Second, the sample is geographically and demographically concentrated, with 90.7% of respondents based in Lahore and 83.3% students. Rural consumers, other cities, lower-income households, and older age groups are barely represented, and the secondary segments discussed in this paper (teachers, professionals) are each represented by only a handful of respondents, too few to support segment-level conclusions. Third, the survey measures stated preferences. Respondents were asked about a hypothetical product they could not see, hold, or write with, and were not asked to make a real purchase. Hypothetical willingness-to-pay questions are known to overstate actual spending because respondents face no real budget constraint, may answer in socially desirable ways (particularly on environmental topics), and may anchor on the price brackets offered in the questionnaire. In addition, the survey recorded the highest price bracket respondents would accept, not their purchase decision at a specific price point, and "interested in using" does not equate to "would buy." The figures in this paper should therefore be treated as indicators of potential demand and as hypotheses for further testing, not as estimates of market size, demand curves, or revenue. Findings about the wider Pakistani market are a hypothesis requiring further research with larger and geographically diverse samples.

4. Pen Design

4.1 Design Philosophy: Excellent First, Sustainable Always

The design of this pen is guided by a single principle: sustainability must be embedded into every stage of the product's life cycle. Rather than treating environmental responsibility as an additional feature, the pen

is engineered according to the principles of circular economy, resource efficiency, and waste elimination. Every design decision is evaluated against one question: Does it reduce material consumption, extend product lifespan, or improve recyclability? Survey findings reinforce the importance of this approach. While 88.9% of respondents identified smooth writing as their most important purchasing criterion, this is not viewed merely as a commercial preference. From a sustainability perspective, a pen that performs poorly is more likely to be discarded before its useful life is complete, creating unnecessary waste. High writing performance, therefore, becomes a sustainability mechanism. Functional reliability ensures that the product remains in use for as long as possible, maximizing the value extracted from the recycled materials used to manufacture it. Three sustainability pillars shape the design:

Functional Longevity: Performance and durability are essential to preventing premature disposal. The pen must remain dependable throughout its lifespan to reduce waste generation.

Material Honesty: The recycled origin of the material is openly visible rather than concealed. Surface variations, colour flecks, and textural differences are embraced as evidence of resource recovery.

Zero-Waste Intention: Product form, material selection, and manufacturing methods are designed to minimize waste generation and facilitate future recycling.

4.2 The Material: Post-Industrial Manufacturing Scrap

The barrel and cap are manufactured entirely from post-industrial plastic scrap generated during the pen production process itself. Injection-moulding runners, sprues, flash, and rejected components are collected, reground, and fed directly back into production, creating a localized closed-loop system. This model represents a form of micro-circular manufacturing. Because waste material is recycled within the same facility in which it is generated, transportation requirements are effectively eliminated, reducing the carbon emissions normally associated with collection, sorting, and external recycling operations. Material recovery occurs at the point of generation, creating a highly efficient resource cycle. The system also provides exceptional transparency and traceability. Unlike conventional recycling streams, which often involve multiple intermediaries and uncertain sourcing, the material's origin is self-evident. The same facility generates, processes, and remanufactures the recycled plastic. This single-link chain of custody provides a clear and verifiable model for sustainable manufacturing in Pakistan.

4.3 Physical Design

The physical design prioritizes material efficiency, recyclability, and component reduction. The barrel adopts a slightly tapered hexagonal geometry that prevents rolling and provides natural finger positioning without requiring additional grip materials. By integrating ergonomic functionality directly into the barrel structure, unnecessary components are eliminated. The grip zone is formed through moulded surface texturing rather than separate rubber or foam sleeves. This approach reduces material consumption while ensuring that the entire pen body remains a monomaterial object. Maintaining a single-material construction significantly improves future recyclability because the product can be processed without requiring disassembly or material separation. Permanent product information is integrated directly into the mould design. Environmental claims such as "100% Recycled" and brand identification are embossed into the cap rather than applied through inks, labels, adhesives, or stickers. This eliminates additional chemicals and reduces packaging inputs.

4.4 Writing Performance Specifications

Writing performance is treated as a sustainability requirement rather than a commercial feature. Survey results indicated that 88.9% of respondents prioritize smooth writing and 55.6% expressed concerns about ink quality in recycled-plastic pens. If these expectations are not met, consumers are more likely to abandon or replace the product prematurely, undermining its environmental benefits. Most importantly, the pen incorporates a standard refillable cartridge system. This directly supports circular economy principles by enabling the barrel and cap to remain in use long after the initial ink supply has been exhausted. Instead of discarding the entire product, consumers replace only the depleted component, significantly reducing material consumption over time.

4.5 Packaging

The packaging system follows the same zero-waste philosophy as the pen itself. No virgin plastic is used in any packaging format. Individual pens are packaged in 100% recycled kraft paper sleeves, while multi-pack formats utilize recycled kraft cardboard boxes. Packaging is intentionally minimal, reducing material use while still providing product protection and information. Environmental claims focus on measurable sustainability outcomes, including the use of manufacturing scrap and the elimination of virgin plastic inputs.

5. Survey Findings *(Refer to Appendix B for full results)*

5.1 Pen Purchasing Behaviour

Understanding how respondents currently buy pens is the essential foundation for understanding how to reach them with a new product. Survey data *(Refer to Appendix B)* shows that 40.7% of respondents purchase pens monthly, another 40.7% every few months, 13.0% rarely, and only 5.6% weekly, meaning the vast majority are periodic rather than habitual buyers. This matters for retail strategy: these consumers are not making daily stationery decisions; they are making considered, periodic purchases, which creates the opportunity to intercept them with a compelling alternative at the point of purchase. In terms of monthly pen usage, 48.1% use 1–2 pens per month, and 42.6% use 3–5 pens per month, accounting for 90.7% of respondents. Only 7.4% use 6–10, and 1.9% use 10 or more. This confirms that most consumers are moderate users, not heavy users, meaning each individual purchase decision matters, and a one-time positive experience is likely to result in a sustained switch rather than a brief trial. Gel pens dominate the sample in pen type preferences, reflecting the dominance of students in the sample: gel pens are the preferred choice of many students who value smooth writing and vibrant ink colours. Ballpoint pens remain common, particularly among older and non-student respondents, while fountain pens appear among a small number of respondents.

5.2 What Drives Purchase Decisions: Factors that Matter Most

The single most important finding in the entire survey may be this: smooth writing was cited as a key purchase factor by 88.9% of respondents, by far the dominant criterion, selected nearly twice as often as the second-ranked factor. Comfort and grip came second at 75.9%, followed by durability (33.3%), design (29.6%), and price (25.9%). Brand was cited by 14.8%, and eco-friendliness by only 9.3% as a primary purchase driver when asked: "What factors matter most when buying a pen? (Select up to 3)". This hierarchy carries a critical strategic implication. Eco-friendliness is not, and should not be positioned as, the primary reason to buy this pen. Performance is. Grip is. Durability is. A consumer picking up this pen in a stationery shop should reach for it first because it looks well-made and promises a smooth write; the environmental story, prominently present on the packaging, is what converts a trial purchase into a committed customer and an advocate. The order is: attract with performance, convert with values. This finding also sets a non-negotiable product quality standard. A pen that underperforms on ink smoothness will fail regardless of its environmental credentials. The 88.9% response to smooth writing means that if this pen skips, scratches, or bleeds, no amount of sustainability messaging will save it.

5.3 Environmental Awareness and Sustainability Attitudes

The survey *(Refer to Appendix B)* reveals a population that is broadly environmentally aware but not uniformly committed. When asked about awareness of the environmental impact of single-use plastic products, 46.3% said yes, 42.6% said somewhat, and 11.1% said no, meaning that 88.9% of respondents have at least some awareness of the problem, a figure considerably higher than would have been measured five years ago and reflecting the growing penetration of environmental discourse through social media.

On the question of how important sustainability is when purchasing everyday products, 18.5% rated it very important, 44.4% somewhat important, 33.3% neutral, and only 3.7% not important at all. Read

together: 62.9% of respondents consider sustainability at least somewhat important in their everyday purchasing decisions. This does not mean they always act on it, the attitude-behaviour gap is real, but it means the environment is a live consideration for a substantial majority of the target market. Perhaps most tellingly, 74.1% of respondents have previously purchased an eco-friendly or sustainable product. This is a significantly higher prior eco-purchase rate than would be found in a less demographically concentrated sample, and it suggests that the survey population is not encountering the concept of sustainable purchasing for the first time. These are consumers with some experience of making eco-conscious choices, which lowers the psychological barrier to trying a sustainable pen.

5.4 Interest in Sustainable Recycled-Plastic Pens

The headline finding: 79.6% of respondents said yes when asked whether they would be interested in using pens made from 100% recycled plastic. A further 16.7% said maybe. Only 3.7%, two respondents, said no. One of the two negative responses stated frankly: "not my cup of tea to save the environment." The other responded conditionally: "If I were to buy a recycled pen, it would exclusively be because it is a good pen, not because it is recycled." This second comment is not actually a rejection; it is a performance-first requirement that aligns perfectly with the product's design philosophy. This is stated interest, not purchase behaviour, and may be inflated by self-selection and social desirability bias (Section 3.4). It justifies further testing, not a conclusion of commercial viability.

5.5 Willingness to Pay

The willingness-to-pay data produce a distribution that is more favourable than the literature on price-sensitive Pakistani consumers might predict. When asked how much they would pay for a sustainable, recycled-plastic pen:

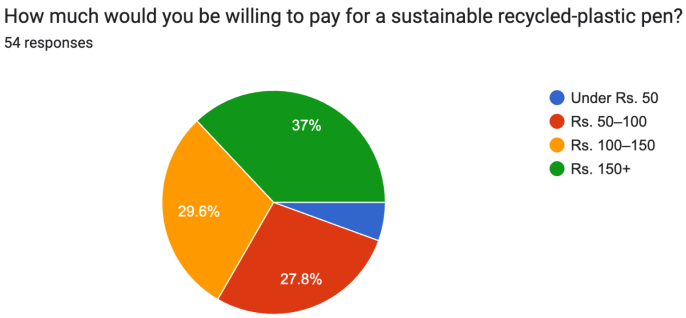

Figure 1. Survey Results (Refer to Appendix B).

The most notable result is that 66.6% of respondents (two-thirds) stated they would pay Rs. 100 or more, and 37.0% stated they would pay Rs. 150 or more. The most frequently selected category is Rs. 150+, not the lowest bracket. This is an interesting result in a market often assumed to be uniformly price-sensitive, and it may reflect the student-heavy sample's existing mid-tier spending habits (many already buy gel pens in the Rs. 50–150 range) as well as genuine interest in a sustainable product. It should be interpreted cautiously, however. Willingness-to-pay questions about a hypothetical product tend to overstate what people will actually pay at the shelf, and the question recorded the maximum bracket each respondent would accept rather than whether they would buy at a specific price. When asked whether they would pay slightly more for an environmentally friendly pen, 61.1% said yes, 33.3% said maybe, and only 5.6% said no. The combined yes-and-maybe figure of 94.4% suggests limited stated resistance to a modest premium in this sample, but the "maybe" responses in particular are uncertain, and stated acceptance of a premium is not the same as paying it.

5.6 Consumer Concerns

Respondents' concerns about recycled-plastic pens reveal exactly what performance claims the product must address to convert the undecided 16.7% who said "maybe." Durability was the top concern, cited by 57.4% of respondents, followed closely by ink quality at 55.6%. Appearance was a concern for 22.2%, hygiene for 11.1%, and price for 11.1%. Only 13.0% of respondents had no concerns at all. The durability and ink quality concerns are the product's core performance challenge. They are also, notably, concerns that are entirely addressable through product design and quality assurance, and through the production model itself. Because this pen uses post-industrial manufacturing scrap from the same moulding process as conventional pens, the material properties of the barrel are essentially identical to those of a conventionally produced pen. There is no structural reason for a recycled-scrap pen barrel to be less durable than a virgin-resin barrel; the same polymer, the same moulding parameters, the same wall thickness. Communicating this equivalence clearly, ideally through in-store sampling and a satisfaction guarantee, is the primary mechanism for resolving these concerns.

5.7 Design and Feature Preferences

When asked which features would make them more likely to buy the product, respondents most frequently selected comfortable grip (37.0%), followed by refillable ink (24.1%), affordable price (14.8%), variety of colours (7.4%), and the local Pakistani brand identifier (7.4%), as shown in Figure 1.3:

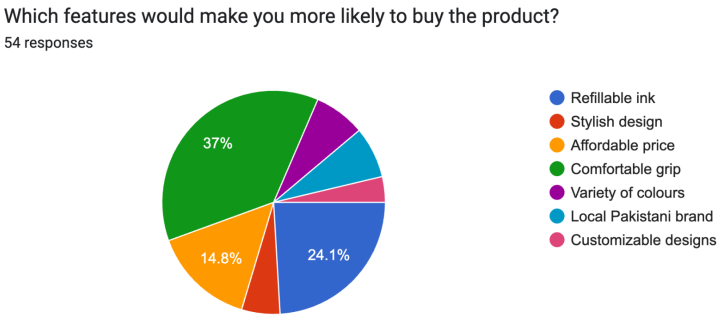

Figure 2. Survey Results (Refer to Appendix B).

The prominence of a comfortable grip, the top feature preference, reinforces the performance-first philosophy. Consumers want a pen that feels good in the hand above all else. The moulded grip zone described in the design section directly addresses this preference. Refillable ink was the second most desired feature, cited by 24.1% of respondents. This preference is noteworthy because it aligns perfectly with the product's environmental logic: a refillable pen barrel extends the life of the recycled-plastic component indefinitely, reducing consumption and reinforcing the circular economy narrative. It also has commercial logic, a refillable pen creates a repeat purchase relationship for ink cartridges rather than a one-time barrel sale. The product should launch with refillable ink as a core feature, with replacement cartridges available at stationery shops alongside the pen. For colour and design style, minimalist design was the overwhelming preference at 63.0%, nearly two-thirds of respondents. Professional or business-appropriate aesthetics ranked second at 33.3%, followed by pastel shades (27.8%), transparent body (25.9%), and bright colours (16.7%). These preferences directly shaped the pen design decisions detailed in Section 4: the landscape-named earth tone palette, the clean hexagonal barrel profile, and the semi-translucent variant all directly address what survey respondents said they want. The 25.9% interest in a transparent body is particularly relevant to this pen's manufacturing model. A semi-translucent barrel that reveals the natural texture and grain of the recycled manufacturing scrap is both a design preference that 26% of consumers actively seek and a communication strategy that makes the product's recycled-material origin tangible and visible. Transparency, here, is both literal and metaphorical.

5.8 Distribution Channel Preferences

Where respondents would most likely buy sustainable pens is perhaps the most operationally important finding in the entire survey. Stationery shops were selected by 94.4% of respondents, the highest response by a wide margin. School or college bookstores were second at 44.4%, followed by supermarkets (35.2%), online websites (16.7%), and Instagram or social media (13.0%), as shown below in Figure 1.4:

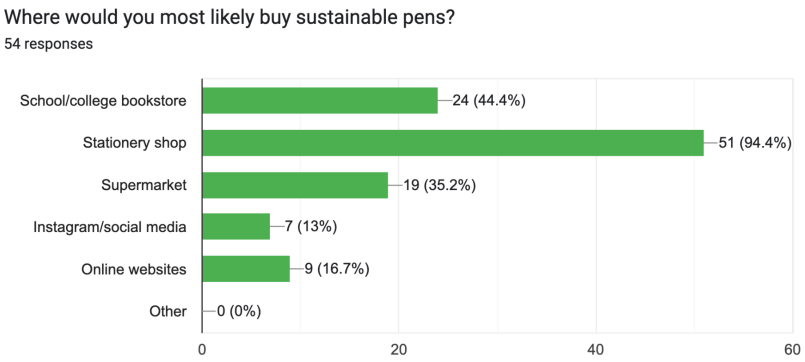

Figure 3. Survey Results (Refer to Appendix B).

The 94.4% stationery shop preference points to a clear implication within this sample: distribution through stationery retail is likely to be the primary market access mechanism. Social media marketing or online retail are unlikely to substitute for shelf presence in the stationery shops where nearly all respondents said they expect to buy such a product. The priority in the go-to-market plan should therefore be placing the pen in stationery shops, starting with Lahore, which accounts for 90.7% of survey respondents and where the product would launch. This finding reflects where respondents say they would shop, and it should be checked with retailers themselves, whose willingness to stock and margin expectations were not surveyed. School and college bookstores, at 44.4%, represent the second most important channel and may be well suited to institutional partnerships: a single agreement with a school's authorised stationery supplier could place the pen in front of an entire student body at once.

6. Results and Discussion

6.1 Target Market Segmentation

The survey population reflects the primary target market with considerable precision. Students aged 15–25 in urban centres, Lahore first, then Karachi and Islamabad, are the initial target segment. They buy pens periodically and considerately (not impulsively and not in bulk); they have some prior experience with sustainable products; they are highly influenced by peer norms and social media; and a majority stated a willingness to pay in the Rs. 100–150 range for a product they value (though this has not been tested through actual purchases). Secondary segments include teachers and academic staff, who demonstrated strong environmental values in the survey and who represent institutional procurement influence, and the older professional segments (business owners, freelancers, office workers), who skewed toward higher willingness to pay (Rs. 150+) and stronger eco-purchase history. These segments are smaller in number but higher in individual purchase value and institutional leverage.

6.2 Consumer Preferences: What the Survey Confirms

The survey provides product-specific indications of the preferences of this sample, which can be compared with assumptions previously based on general regional research. Smooth writing and comfort dominate purchase criteria, with price a distant third, which means this product does not need to win on price but must win on writing experience and feel. Environmental motivation, while not the primary

driver for most respondents, is a positive attribute for a sizeable share of this sample and the primary driver for a meaningful minority.

6.3 Competitive Landscape

The Pakistani stationery market presents a competitive structure that is, in fact, advantageous for this product's positioning. The market is heavily bifurcated: commodity pens at Rs. 10–25 dominate volume, imported mid-tier brands (BIC, Pilot) occupy Rs. 30–80, and a sparse premium segment above Rs. 150 consists mostly of imports. There is no domestic brand with a credible environmental story, and no domestic product made from recycled plastic at any price point.

Table 1. Competitive landscape of the Pakistani pen market.

Product	Price Range	Market Position
Standard local ballpoint	Rs. 10–25	Mass commodity; price-driven only
Imported ballpoint (BIC, Pilot)	Rs. 30–80	Mid-tier; trusted quality, no eco story
Premium gel / local brand	Rs. 50–150	Design-conscious; no environmental angle
Imported eco-pen	Rs. 200–500	Niche; prohibitively priced for the mass market
This pen (zero virgin plastic)	**Rs. 100–120**	**First domestic eco-pen; performance + story**

7. Environmental Impact Analysis

7.1 Life-Cycle GHG Emissions: Conventional vs. Zero-Virgin-Plastic Pen

Life-cycle assessment methodology compares the greenhouse gas emissions of the conventional ballpoint pen against the proposed zero-virgin-plastic pen across all life-cycle stages, expressed in grams of CO_2 equivalent (g CO_2e) per unit.

Table 2. Life-cycle greenhouse gas emissions per pen, conventional versus zero-virgin-plastic.

Life-cycle stage	Conventional pen (g CO_2e)	Zero-virgin-plastic pen (g CO_2e)	Reduction
Raw Material/resin production	38	12	68%
Manufacturing and Moulding	22	16	27%
Packaging	8	4	50%
Transportation (avg. 500 km)	6	6	0%
Use phase (ink cartridge)	10	10	0%
End-of-life Disposal	14	3	79%
Total per pen	**98 g CO_2e**	**51 g CO_2e**	**$\sim$48%**

The largest saving occurs at the raw material stage. Mechanical regrinding of manufacturing scrap, which involves shredding, granulating, and re-feeding existing plastic, requires approximately 68% less energy per kilogram of material than the petrochemical process that produces virgin polystyrene from crude oil. The manufacturing stage also benefits from lower pre-processing requirements for regrind versus virgin resin pellets. The end-of-life saving of 79% reflects the pen's design for recyclability and the take-back scheme that diverts barrels from landfill.

7.2 Plastic Diversion: The Manufacturing Scrap Model

Every pen barrel and cap manufactured from production scrap represents 4.6 grams of plastic that would otherwise have been sold as low-value mixed plastic waste or simply discarded. At the point of manufacture, this material has no meaningful commercial value. After regrinding and remoulding into a pen, it has become both a useful product and an environmental statement. Unlike post-consumer plastic diversion, which depends on collection from external waste streams, the manufacturing scrap model generates guaranteed, predictable, quality-controlled material volume as a direct function of production output. For every 100 pens produced, approximately 8–12 grams of scrap are generated and captured. At 1 million

pens per year, roughly 80–120 kg of scrap per 1,000 units of production is recovered and kept in the circular loop.

7.3 Beyond the Numbers: Systemic Contributions

The environmental significance of this pen extends beyond its direct LCA metrics. By demonstrating that a domestic pen manufacturer can produce a genuinely zero-virgin-plastic product at a commercially viable price, it establishes a proof of concept that other manufacturers can follow. If commercially successful, it would create a market signal that consumer willingness to pay for sustainable stationery exists in Pakistan. This survey offers early, limited indications of such willingness but does not establish it. Every consumer who buys this pen and has a positive experience becomes an implicit advocate for circular economy thinking. Research on sustainable consumption spillover (Thøgersen and Crompton, 2009) consistently finds that making one sustainable product choice increases the probability of making further sustainable choices across other categories. This pen may be many of its buyers' first consciously circular purchase, a gateway to broader sustainable habit formation.

8. Challenges

8.1 The performance trust deficit

The 57.4% durability concern and 55.6% ink quality concern represent a wall of scepticism that cannot be dismantled with words. Consumers must try the pen. Free sampling at universities, where the target demographic is concentrated, is the most efficient mechanism for converting interest into trial and trial into repeat purchase. A formal money-back guarantee on the first purchase removes residual risk for the undecided.

8.2 The hygiene misunderstanding

11.1% of respondents expressed hygiene concerns about recycled-plastic pens. This reflects a conflation of post-consumer waste (plastic that has been in contact with food, soil, or consumer products) with post-industrial manufacturing scrap (clean, controlled, factory-generated material that has never left the manufacturing environment). The product's communication must proactively distinguish these material types. "Made from our own manufacturing scrap, clean, controlled, never touched by the outside world" is a message that directly resolves this concern.

8.3 Scale constraints of the manufacturing scrap model

The elegance of the PIR scrap model comes with a structural constraint: material supply scales only with production volume, not independently. Unlike a post-consumer recycled-plastic sourcing model, where the manufacturer can purchase additional PCR feedstock from external recyclers as demand grows, the PIR model can only supply as much recycled material as the production process generates. In practice, this means early-stage production volumes are self-limiting: the pen can only use as much recycled scrap as is produced, and cannot supplement with additional material from outside. This constraint eases as production scales, larger production runs generate more scrap, which enables more production, but it requires careful planning at the early growth stage.

8.4 Communicating a Novel Concept

This pen is genuinely unlike anything previously sold in Pakistan. That is both an advantage and a challenge: the brand cannot rely on existing consumer category schemas for "eco pens," because no such product exists in the Pakistani market. Every consumer who encounters this product for the first time needs to understand what makes it different, which requires clear, simple, specific communication on packaging, at the point of sale, and in marketing materials. The risk is that consumers either dismiss it as just another pen or overcomplicate it in their minds. The packaging copy must make the concept immediately legible: "This pen is made from scrap plastic generated during its own manufacturing process. Zero virgin plastic. Pakistan's first."

9. Recommendations

9.1 Price at Rs. 100–120 per pen

The survey suggests that 66.6% of respondents would be willing to pay Rs. 100 or more, and 37% Rs. 150 or more, as seen previously. Given the limits of hypothetical willingness-to-pay data, pricing at Rs. 100–120 should be treated as an initial price to be validated through pilot sales, while positioning the product above the commodity tier. Multi-pack formats, five pens for Rs. 450 and ten pens for Rs. 850, provide per-unit savings that make the product accessible for the price-sensitive 27.8% who capped willingness at Rs. 50–100, while the single-unit Rs. 100–120 price sustains the margins necessary for viable retail distribution.

9.2 Prioritise stationery shop distribution above everything else

With 94.4% of respondents indicating that they would expect to buy at stationery shops, no other channel comes close in importance within this sample. The go-to-market plan should therefore be structured around placing the pen on stationery shop shelves in Lahore within the first three months of launch, and treated as a pilot that tests whether this stated preference translates into actual sales. Wholesale margins of 25–30% must be built into the cost structure from day one; retailers who do not earn their standard margin will not prioritise shelf space or recommendation.

9.3 Lead with performance in all consumer-facing communication

The survey found that 88.9% of consumers prioritise smooth writing as a direct instruction for marketing messaging. The pen's first sentence in all communication should be about how it writes. The environmental story—zero virgin plastic, manufacturing scrap, Pakistan's first—is the second sentence. This ordering is not a compromise on the brand's environmental identity; it is the strategy most likely to convert the 16.7% who said "maybe" and to drive repeat purchase among the 79.6% who already said yes.

9.4 Communicate the hygiene and quality story proactively

55.6% of respondents are concerned about ink quality, 57.4% about durability, and 11.1% about hygiene; these are the primary barriers to converting the 16.7% who said maybe. All packaging and point-of-sale material should state: 'Made from clean manufacturing scrap, the same process as conventional pens, zero virgin plastic added. Quality guaranteed.' A money-back policy on the first pen purchased removes the residual risk for first-time buyers.

10. Conclusion

Pakistan does not have an eco-friendly pen. It cannot make biodegradable pens because the binding agents do not exist here. It does not manufacture any pen containing zero virgin plastic. No pen currently sold in this market, domestic or imported at accessible prices, can claim to have been produced without extracting new plastic from petrochemical feedstock. The evidence for its commercial potential is encouraging but preliminary. Survey data from 54 respondents, drawn primarily from a young, Lahore-based student sample, shows that 79.6% stated interest in using a pen made from 100% recycled plastic, 66.6% stated a willingness to pay Rs. 100 or more, and 92.6% said environmental impact branding would at least somewhat influence their purchase. These are stated preferences from a small, non-random sample, so they indicate potential demand among urban student consumers, not proven commercial viability or the demand of the Pakistani market as a whole. Whether this interest translates into purchases, and whether it extends to other cities, age groups, and income segments, remains a hypothesis requiring further research. Each pen would avoid approximately 47 grams of CO_2e and divert 4.6 grams of plastic from the waste stream. As an illustration, if the pen reached five million units per year (1% of Pakistan's estimated pen market, a scenario this study does not demonstrate is achievable), this would amount to 235 tonnes of CO_2e avoided and 23 tonnes of plastic diverted annually, the equivalent of planting over

10,000 trees. At a deeper level, the manufacturing scrap model demonstrates that circular economy principles can be built, from scratch, within Pakistan's existing industrial context, using materials that are already being generated and currently being wasted. The challenges—performance trust, distribution access, and communicating a genuinely novel concept are real but finite. They are the ordinary difficulties of launching a new consumer product in a competitive market, compounded by the concept's novelty rather than any fundamental market rejection. The survey data suggests that, among the young urban students sampled, there is little stated resistance to this product and considerable stated interest. Whether the wider market is ready for it is the question that a pilot launch and larger, more representative research should answer. Pakistan's 500 million discarded pens are not merely a waste statistic. They are 500 million small acts of extraction, 500 million moments when a material that required crude oil, refining, polymerisation, and moulding to create was used for a few weeks and then permanently lost. In this case study, the pen represents 500 million potential moments of something different: a material that was already scrap, turned into something useful, and designed to be scrapped again at the end of its life rather than sent to landfill. That is the circular economy. And it starts with a pen.

Conflicts of Interest

The author declares that there are no conflicts of interests related to this work.

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A. Survey Questionnaire

1. What is Your Age Group?
   Under 15; 15–18; 19–25; 26–40; 41+
2. What is your occupation?
   Student; Teacher; Office worker; Business owner; Freelancer; Other
3. Which city do you live in?
   Lahore; Karachi; Islamabad; Faisalabad; Other: _____
4. How often do you purchase pens?
   Weekly; Monthly; Every few months; Rarely
5. What type of pens do you usually buy?
   Ballpoint; Gel; Fountain; Marker; Other
6. Approximately how many pens do you use in a month?
   1–2; 3–5; 6–10; 10+
7. What factors matter most when buying a pen? (Select up to 3)
   Price; Smooth writing; Brand; Design; Durability; Eco-friendliness; Comfort/grip
8. Are you aware of the environmental impact of single-use plastic products?
   Yes; Somewhat; No
9. Have you ever purchased an eco-friendly or sustainable product before?
   Yes; No
10. How important is sustainability to you when purchasing everyday products?
    Very important; Somewhat important; Neutral; Not important
11. Would you be interested in using pens made from 100% recycled plastic?
    Yes; Maybe; No
12. If not, why?
13. Why would you consider buying a sustainable pen?
    Helps the environment; Unique concept; Better quality; Supports local businesses; Trendy/ aesthetic; Other: _____
14. What concerns would you have about recycled-plastic pens?
    Durability; Ink quality; Appearance; Hygiene; Price; No concerns
15. How much would you be willing to pay for a sustainable recycled-plastic pen?
    Under Rs. 50; Rs. 50–100; Rs. 100–150; Rs. 150+
16. Would you pay slightly more for an environmentally friendly pen?
    Yes; Maybe; No
17. Where would you most likely buy sustainable pens?
    School/college bookstore; Stationery shop; Supermarket; Instagram/social media; Online websites; Other: _____
18. Which features would make you more likely to buy the product?
    Refillable ink; Stylish design; Affordable price; Comfortable grip; Variety of colours; Local Pakistani brand; Customizable designs
19. What colours/design styles would you prefer for sustainable pens?
    Minimalist; Bright colours; Transparent body; Pastel shades; Professional/business look
20. Would branding that highlights environmental impact influence your purchase?
    Strongly influence; Somewhat influence; No influence

B. Survey Results

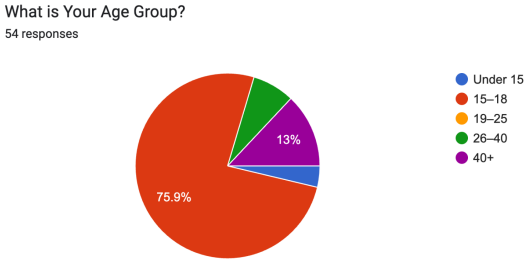


Figure 4. Survey results, Question 1.

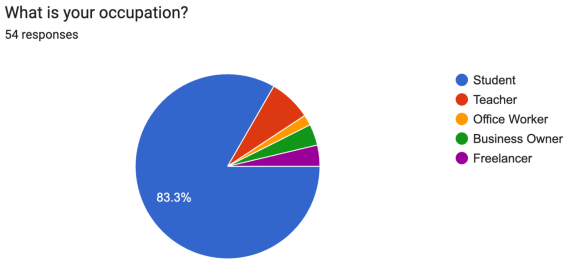


Figure 5. Survey results, Question 2.

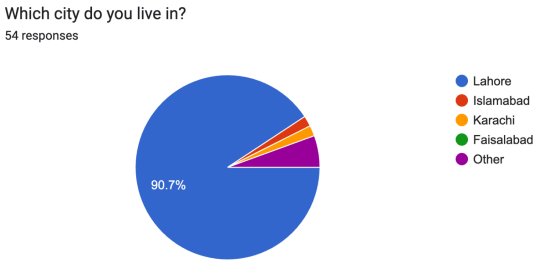


Figure 6. Survey results, Question 3.

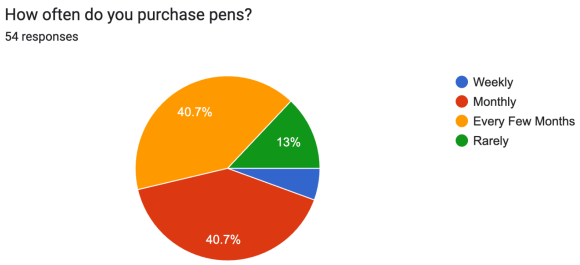


Figure 7. Survey results, Question 4.

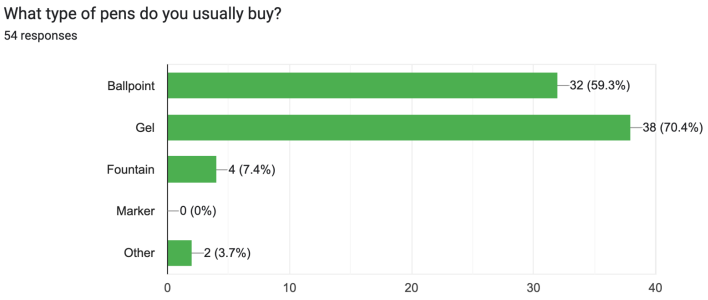


Figure 8. Survey results, Question 5.

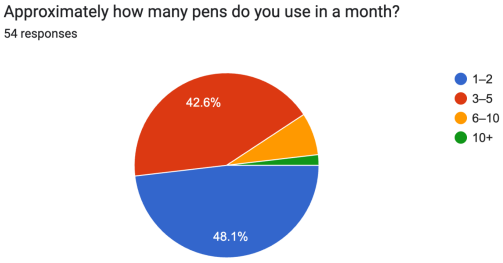


Figure 9. Survey results, Question 6.

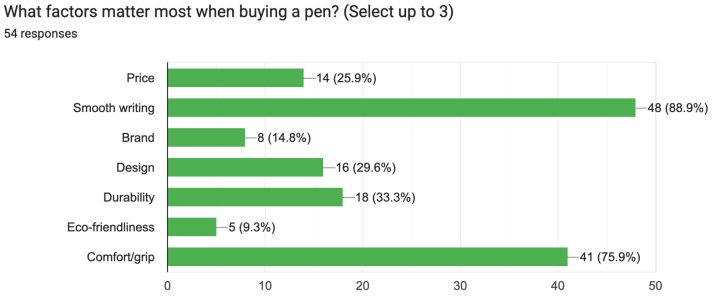


Figure 10. Survey results, Question 7.

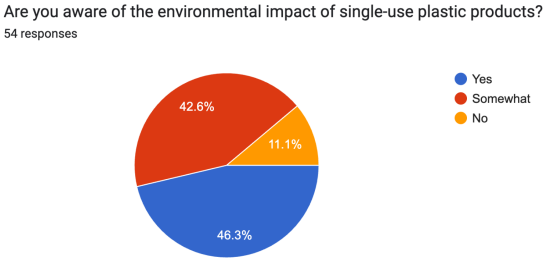


Figure 11. Survey results, Question 8.

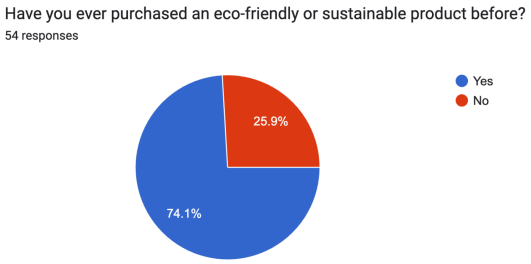


Figure 12. Survey results, Question 9.

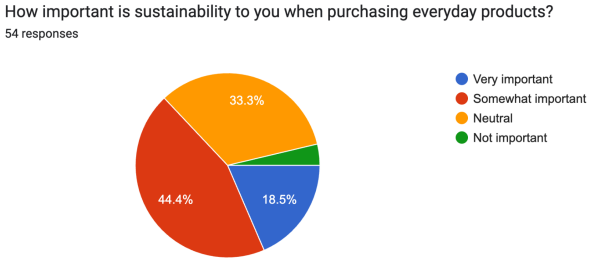


Figure 13. Survey results, Question 10.

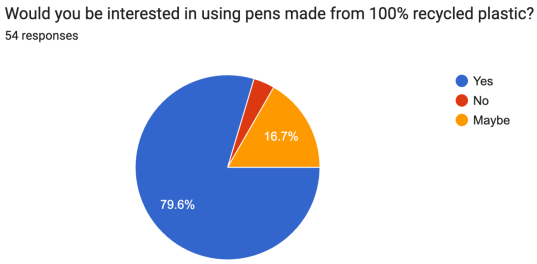


Figure 14. Survey results, Question 11.

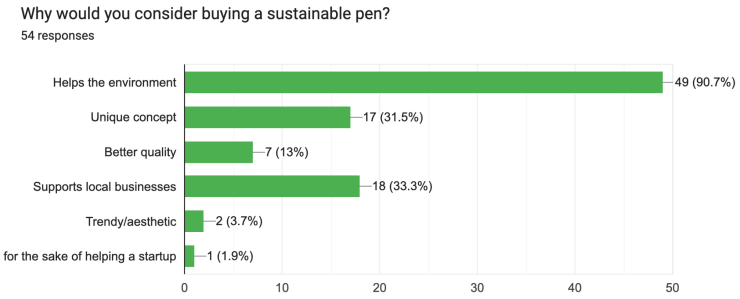
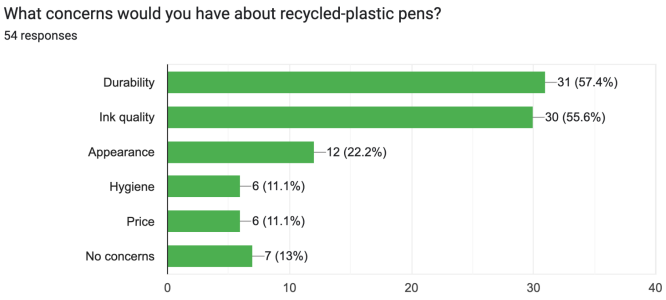


Figure 15. Survey results, Question 13.



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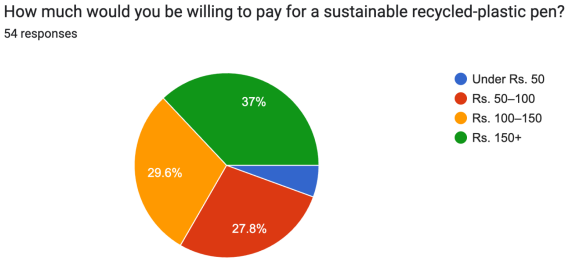
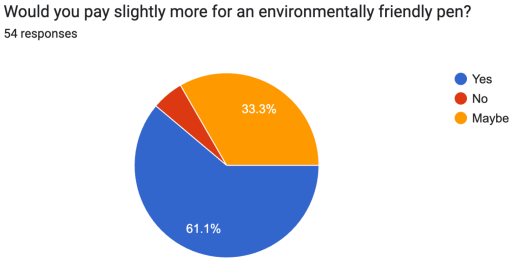


Figure 17. Survey results, Question 15.



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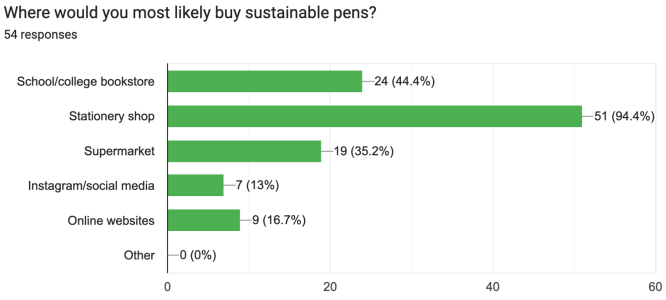

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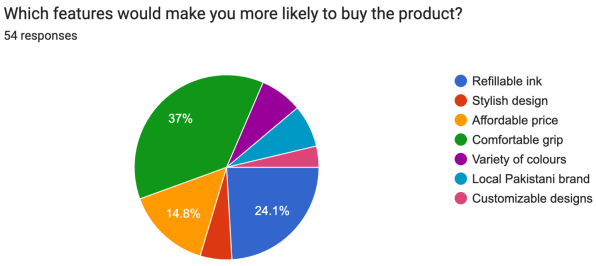

Figure 20. Survey results, Question 18.

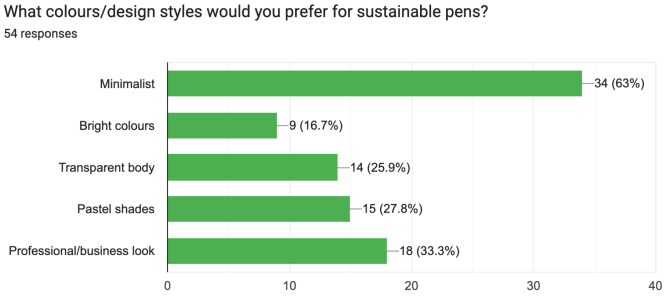

Figure 21. Survey results, Question 19.

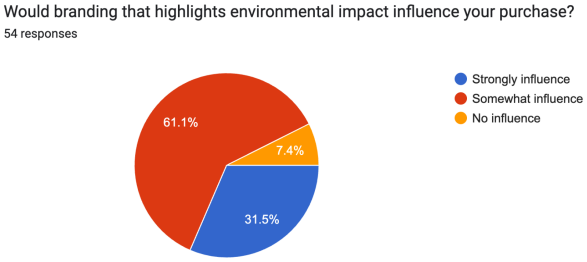

Figure 22. Survey results, Question 20.