Consumers' acceptance of recycled products: Instrument development and pilot testing

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Abstract. One possible solution to the issue of excessive use of natural resources is the use of recycled materials in the manufacturing of new products. Aside from the extent to which recycled materials are integrated into industrial processes, a key question to investigate is whether consumers actually value such efforts and products. Therefore, the main objective of this article is to create and test a instrument to measure customer acceptance of recycled products. A pilot test with a sample totalling 168 individuals was conducted to achieve this goal. By using an exploratory factor analysis, a final structure of three factors describing consumers' acceptance of recycled products was discovered: 1) perceived environmental benefit, 2) perceived credibility of 3) price perception.

1 Introduction

Although the earth's natural resources are scarce, humans continue to use far more of them than the environment can replenish. The primary drivers of environmental degradation are unsustainable patterns of production and consumption, including anthropogenic activities exerting an impact on the environment through waste generation and the carbon footprint. The use of recycled materials in the manufacture of new products is one of the viable solutions to the issue of excessive use of natural resources. PET plastic bottles and recycled paper may be the most pertinent recycling examples [1,2].

To that purpose, businesses can implement a closed-loop system in which resources are returned and re-circulated after usage. The notion of circularity is frequently examined in the context of companies, but academics are beginning to investigate the contribution of the consumer in closed-loop systems [3], stressing consumers' poor comprehension of the circular economy [4]. Recycling is the process of reusing materials from discarded products rather than raw materials to create new products of equal quality [5,6]. In contrast, "upcycling" refers to the reuse of materials to generate higher-quality products, whereas "downcycling" provides lower-value items [7]. Recycling provides various significant environmental benefits, including the decrease of water and air pollution, greenhouse emissions, and waste, in addition to conserving the earth's scarce natural resources [8, 9].

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In other words, corporations adopt the circular economy business model, in which, instead of a wasteful 'extract-use-dispose' approach, they keep used products from consumers and feed them back into a closed looped reuse system. However, the transition to circular products is accompanied by new product features that change the user experience [10,1]. Furthermore, a comprehensive approach is required to attract environmentally conscious buyers to recycled products without compromising quality, performance, or aesthetics. It is equally important to educate consumers about the environmental and social benefits of supporting circular economy practices [11]. Existing research [12] demonstrates that customers are less ready to pay for recycled products than for products created from new materials, implying that recycled products have a higher perceived risk [13]. Hence, aside from the extent to which recycled materials are integrated into manufacturing processes, the essential question that remains is whether consumers truly appreciate such efforts [1]. According to the studies conducted so far on the variables influencing the consumption of recycled products, consumers view recycling and the use of recycled products as a way to support the environment and demonstrate their sense of social responsibility [14]. There are also differences brought about by the demographic variables (such as an income above average, a high level of education or the age) influencing the purchasing behaviour of these products [15]. Nonetheless, important aspects of customers' contributions to product circularity remain unexplored. Despite a growing corpus of research on green marketing, the customer decision-making process for choosing sustainably produced items is little understood [16]. Consumers regularly express major environmental concerns, but their purchasing habits may not always reflect these concerns.

Therefore, the purpose of the research is to create a measurement instrument with satisfactory psychometric characteristics for assessing consumers' acceptance of recycled goods. Measurement tools are a crucial component of quantitative research methodology and have significant consequences for the reliability of empirical findings. Only accurate and reliable measurements, regardless of the kind (nominal, ordinal, interval, or proportion), are capable of demonstrating how a well-reasoned theory connects to its applicability in practice. The article aims to evaluate the proposed instrument using the exploratory factor analysis (EFA) method, an important statistical method when the goal is to validate a newly created instrument.

2 Materials and methods

A non-experimental cross-correlation approach will be employed in this research. This design involves measuring all variables simultaneously at once. The main advantages of this design are the ease with which all data can be collected, as well as the fact that they can be collected anonymously, which can reduce the social desirability of the participants, whilst addressing the ethical issues related to the protection of the participant's identity. This approach also makes online administration easier. The steps used throughout this research will be outlined in the following sections, in order to assure the transparency and replicability of the results obtained.

2.1 Overall methodology

Generally, the exploratory factorial analysis aims to identify the smallest set of factors that explain the pattern of existing correlations between the items under analysis, which reflect underlying (hypothetical) processes with an impact on behaviour. Despite the fact that AFE appears to be an elaborate statistical approach, the analysis procedure to be used is sequential and linear, with various options [17,18]. As a result, adhering to a protocol was necessary.

The overall methodological approach is presented as it follows.

1. Literature analysis: identification and analysis of papers published up to current date that have already addressed the measurement of recycled products acceptability or similar concepts.
2. Item generation: the authors developed the items according to the recommendations provided by Marjorie [19].
3. Pre-testing- this phase consisted of administering the questionnaire to a number of 5 people in order to check its validity and solve possible discrepancies or drafting errors.
4. Data collection and dissemination – after the questionnaire was pretested, it was disseminated in an online version to several organizations that further distributed the questionnaire to their employees as well as to several higher education institutions that in turn disseminated it to students (snowballing technique). The data was collected during March, 2023.
5. Database preparation – after the data was collected, we proceed to database preparation consisting of entering and coding the variables, as well as removing incomplete or anormal responses.
6. Descriptive analyses – this phase involved basic statistical analyses such as means, standard deviations, and frequencies.
7. Inferential analyses- in this stage we conducted covariance analysis, specific tests such as the Bartlett test of sphericity, the Kaiser-Meyer-Olkin (KMO) test, factor rotation.
8. Interpretation of the results - finally, based on the results obtained and their statistical significance, conclusions and future research directions were formulated.

2.2 Sample

This study's sample is a convenience sample, with individuals recruited by the snowball approach from private organizations and higher education institutions. The questionnaire was administered online while adhering to all data protection rules. The initial sample consisted of 208 individuals. However, after checking for missing data and other inaccuracies, the final sample resulted was of 168 participants. Table 1 depicts the strata of the studied sample.

Table 1. Sample description.

Criteria	Class	%
Gender	Female	45.83%
	Male	53.57%
	I do not wish to answer	0.60%
Age	18−25 years	60.12%
	26−30 years	10.12%
	31−40 years	18.45%
	41−50 years	9.52%
	51−60 years	1.79%
	60+ years	0%
Residency	Urban	70.66%
	Rural	29.34%
Occupation	Employee	52.98%
	Entrepreneur	5.36%
	Student	37.50%
	Unemployed	0.60%
	Others	1.79%
	Freelancer	1.79%

Education	Highschool	60.12%
	Bachelor degree	25%
	Master degree	11.90%
	Doctoral degree	2.98%
	Post-doctoral studies	0%
Region	North-East Region	0.60%
	South-East	1.79%
	South-Muntenia	0%
	South-West Oltenia	16.67%
	West Region	0.60%
	North-West Region	9.52%
	Central Region	70.24%
	Bucharest-Ilfov Region	0.60%
Monthly income	1000-2000 RON	35.71%
	2001-3000 RON	10.12%
	3001-4000 RON	16.07%
	4001-5000 RON	14.29%
	5001-6000 RON	11.90%
	6001+ RON	11.90%

The gender of the respondents and the average monthly income show a balanced structure. The majority of people are between the ages of 18 and 25, and they live in cities. The table below details all of the sample layers.

2.3 Data analysis

Factorial analytic procedures are statistical approaches for investigating correlations among variables assessed by questions or items. It is vital to emphasize that factor analysis is not a single statistical method, but rather a collection of statistical analyses with similar methodologies and functions. The theoretical and mathematical underpinnings of the procedures allow the analyses to adapt to a wide range of research purposes and theories, resulting in the tool's extensive use across fields and applications [20, 21].

The goal of factor analysis is to explain the variation and covariance in a set of (manifest) variables using fewer dimensions (factors). The factor is a latent variable that influences numerous manifest variables, explaining their association. In other words, it is a simplified explanation of the relationships that exist between the variables that are being assessed [18].

In this study, the variable for which it is desired to construct a measuring instrument is the degree of consumer acceptance of recycled products [22, 23]. The proposed structure consists of five possible factors (Table 2) as follows:

1. Perceived quality: is the individual's subjective assessment of a product's superiority or quality;
2. Purchase intention: reflects how likely consumers are to purchase a good or service within a specific time frame;
3. Price perception: refers to the price that consumers are willing to pay for a certain good or service based on how they personally view it;
4. Environmental concern- the degree to which consumers are worried about environmental threats [20], which influences environmentally friendly actions like recycling purchases;
5. Perceived social value: describes the social desirability connected to the purchase of the goods as a result of other customers' favourable perceptions.

All the items are quantified on a 5-point Likert Scale, where 1 (strongly disagree) means a low level of consumer acceptance and 5 (strongly agree) means a high level of consumer acceptance.

Table 2. Initial items of the instrument.

Factor 1. Perceived quality	1.1 Generally, I find the quality of recycled products satisfactory.
	1.2 The quality of the recycled products corresponds to my expectations.
	1.3 I believe that recycled products have a long life.
Factor 2. Purchase intention	2.1 I am determined to buy recycled products in the future.
	2.2 I will continue to buy recycled products in the future.
	2.3 I will buy recycled products even if alternatives such as conventional products without recycled content are available.
Factor 3. Price perception	3.1 The price of recycled products is justified
	3.2 I believe that the price of recycled products fairly reflects their quality
	3.3 I can afford to buy recycled products.
Factor 4. Environmental concern	4.1 Recycled products helps counteracting environmental problems.
	4.2 I believe that recycled products have a low impact on the environment.
	4.3 The purchase of recycled products is important for resource conservation.
	4.4 By buying recycled products, I demonstrate responsibility towards the environment.
Factor 5. Perceived social value	5.1 Consumers who choose recycled products shop smart.
	5.2 Recycled products have a favourable image on the market.
	5.3 It is appreciated when a person chooses to buy recycled products.
	5.4 People who purchase recycled products demonstrate a high level of responsibility

3 Results

3.1 Preliminary analysis

This section is devoted to database screening, testing the assumptions of exploratory factor analysis, and sample adequacy. Table 3 shows the descriptive statistics obtained in for each variable (in this case, items), such as the mean and standard deviation. This step is useful for identifying missing cases that could affect further analyses. As can be seen, there are no missing cases and the descriptive indicators fall within normal parameters. Next, we analysed the Pearson correlation matrix generated by SPSS. In the case of EFA, this is particularly important, especially in the preliminary stage of data analysis, as correlations of extremely high or low intensity affect the factorial structure. The first part at the top of the matrix contains the correlation coefficient for each possible pair of items, and the bottom part shows the statistical significance threshold (p) value [17].

Table 3. Descriptive statistics.

Item	M	SD	N
Generally, I find the quality of recycled products satisfactory.	3.95	.857	168
The quality of the recycled products corresponds to my expectations.	3.86	.895	168
I believe that Recycled products have a long life.	3.63	.989	168
I am determined to buy recycled products in the future.	4.02	.938	168
I will continue to buy recycled products in the future.	4.01	.945	168
I will buy recycled products even if alternatives conventional such as products without recycled content are available.	3.77	.922	168
The price of recycled products is justified	3.67	.964	168
I believe that the price of recycled products fairly reflects their quality	3.71	.949	168
I can afford to buy recycled products.	4.21	.834	168
Recycled products helps counteracting environmental problems.	4.05	.921	168
I believe that recycled products have a low impact on the environment.	3.79	1.169	168
The purchase of recycled products is important for resource conservation.	4.20	.835	168
By buying recycled products, I demonstrate responsibility towards the environment.	4.05	.962	168
Consumers who choose recycled products shop smart.	3.84	.943	168
Recycled products have a favorable image on the market.	3.73	.946	168
It is appreciated when a person chooses to buy recycled products.	4.11	.865	168
People who purchase recycled products demonstrate a high level of responsibility	3.99	.973	168

In this case, it is important to analyse if there are correlations lower than 0.3, as the respective item would not match the rest, and higher than 0.9, which indicate collinearity. Table 4 illustrates the correlation matrix. As noted, we have not identified any correlations that violate these rules. The highest correlation identified is between items 2.1 and 2.2 ($r=0.86$, $p<0.05$) and the smallest ($r=0.31$, $p<0.05$) between 4.4 and 1.1, so we continued with the sample viability test.

Table 4. Correlation matrix.

	Item 1.1	item 1.2	item 1.3	Item 2.1	item 2.2	item 2.3	item 3.1	item 3.2	item 3.3	item 4.1	item 4.2	item 4.3	item 4.4	item 5.1	item 5.2	item 5.3	item 5.4
item 1.1	**1.00**	.709	.591	.545	.585	.492	.335	.355	.368	.385	.312	.350	.301	.352	.321	.452	.323
item 1.2	.709	**1.00**	.496	.580	.610	.556	.313	.391	.320	.448	.201	.348	.377	.420	.245	.452	.363
item 1.3	.591	.496	**1.00**	.543	.515	.547	.440	.490	.447	.533	.401	.423	.386	.493	.395	.372	.425
item 2.1	.545	.580	.543	**1.00**	.865	.683	.410	.463	.415	.485	.326	.477	.503	.517	.289	.477	.506
item 2.2	.585	.610	.515	.865	**1.00**	.682	.416	.383	.420	.416	.240	.461	.428	.471	.257	.424	.424
item2.3	.492	.556	.547	.683	.682	**1.00**	.540	.525	.415	.392	.287	.464	.568	.611	.407	.476	.578
Item 3.1	.335	.313	.440	.410	.416	.540	**1.00**	.635	.530	.358	.371	.283	.430	.497	.486	.448	.515
item 3.2	.355	.391	.490	.463	.383	.525	.635	**1.00**	.443	.402	.457	.468	.529	.526	.470	.512	.596
item 3.3	.368	.320	.447	.415	.420	.415	.530	.443	**1.00**	.392	.338	.369	.369	.395	.297	.392	.348
item 4.1	.385	.448	.533	.485	.416	.392	.358	.402	.392	**1.00**	.495	.541	.575	.546	.393	.522	.527
item 4.2	.312	.201	.401	.326	.240	.287	.371	.457	.338	.495	**1.00**	.460	.436	.397	.336	.427	.414
item 4.3	.350	.348	.423	.477	.461	.464	.283	.468	.369	.541	.460	**1.00**	.561	.496	.356	.549	.511
item 4.4	.301	.377	.386	.503	.428	.568	.430	.529	.369	.575	.436	.561	**1.00**	.702	.457	.648	.750
item 5.1	.352	.420	.493	.517	.471	.611	.497	.526	.395	.546	.397	.496	.702	**1.00**	.534	.558	.644
item 5.2	.321	.245	.395	.289	.257	.407	.486	.470	.297	.393	.336	.356	.457	.534	**1.00**	.448	.537
item 5.3	.452	.452	.372	.477	.424	.476	.448	.512	.392	.522	.427	.549	.648	.558	.448	**1.00**	.742
item 5.4	.323	.363	.425	.506	.424	.578	.515	.596	.348	.527	.414	.511	.750	.644	.537	.742	**1.00**

Next, the value of the KMO test (table 5) can take values between 0 and 1. A value close to 0 indicates a high diffusion of the correlation pattern, which would make factor analysis ineffective. Conversely, a value close to 1 indicates a compact correlation pattern, which allows the extraction of valuable factors.

The value obtained for this sample is 0.9, which means that the sample size is adequate for factor analysis. Also, the Barlett test of sphericity, if it gives a statistically significant result ($p<0.05$) it is confirmed that the correlations between the variables are different from 0. In this case, the test came out statistically significant, so we concluded that the preliminary assumptions have been met and the sample is suitable for instrument testing [17, 20].

Table 5. KMO and Barlett Test of Sphericity.

KMO and Bartlett Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,914
Bartlett's Test of Sphericity	Approx. Chi-Square	1823,865
	df	136
	Sig.	,000

3.2 Factor extraction

The first part of the factor extraction process is the determination of the linear components between the variables - the eigenvectors. To determine how many factors to retain, the standard procedure is to apply criteria of the magnitude of these factors. Thus, the Kaiser Criterion suggests us to keep only those eigenvalues that pass the threshold of 1 [24]. As can be seen in table 6, in this case 3 eigenvectors pass this threshold, indicating that it is possible that the instrument has a structure of 3 factors, representing in total approximately 65% of the variance of the degree of acceptance of recycled products.

Table 6. Eigen Values for each factor.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% Variance	Cumulative %	Total	% Variance	Cumulative
1	**8.357**	**49.157**	**49.157**	8.357	49.157	49.157
2	**1.699**	**9.997**	**59.154**	1.699	9.997	59.154
3	**1.012**	**5.955**	**65.109**	1.012	5.955	65.109
4	.913	5.370	70.479			
5	.784	4.613	75.092			
6	.578	3.401	78.493			
7	.532	3.128	81.621			
8	.503	2.962	84.583			
9	.463	2.726	87.309			
10	.423	2.490	89.798			
11	.363	2.134	91.933			
12	.321	1.890	93.823			
13	.289	1.701	95.524			
14	.264	1.550	97.075			
15	.199	1.170	98.245			
16	.184	1.085	99.330			
17	.114	.670	100.000			
Extraction Method: Principal Component Analysis.						

According to the existing analysis techniques [17, 18], in order to corroborate this three-factor structure, the "Scree" graph must also be examined. In order to authenticate the data obtained about the instrument's three-factor structure, an inflection should be present on the vertical axis at factor number 3. This was indeed the case, thus we chose to proceed with the three-factor structure.

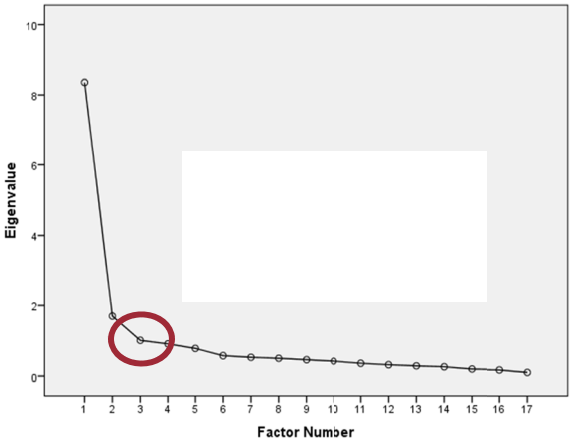

Fig. 1. Scree plot.

3.3 Factor rotation

The rotation of the variables clarifies the instrument's structure, being a process aimed at improving the structure gained during the extraction procedure [25]. In this case, we used the SPPS to perform an oblique Varimax rotation. Table 7 already demonstrates the instrument's clear structure on three main factors.

Table 7. Factorial loadings after Varimax Rotation.

Item	Factor		
	1	2	3
4.4 By buying recycled products. I demonstrate responsibility towards the environment.	**.792**		
5.4 People who purchase recycled products demonstrate a high level of responsibility	**.758**		.305
5.3 It is appreciated when a person chooses to buy recycled products.	**.723**		
5.1 Consumers who choose recycled products shop smart.	**.636**	.330	.312
4.3 The purchase of recycled products is important for resource conservation.	**.612**	.336	
4.1 Recycled products helps counteracting environmental problems	**.591**	.358	
4.2 I believe that recycled products have a low impact on the environment.	**.496**		
5.2 Recycled products have a favorable image on the market.	**.468**		.406
2.2 I will continue to buy recycled products in the future.		**.812**	
2.1 I am determined to buy recycled products in the future.	.365	**.755**	
1.2 The quality of the recycled products corresponds to my expectations.		**.738**	
1.1 Generally. I find the quality of recycled products satisfactory		**.724**	
2.3 I will buy recycled products even if alternatives conventional such as products without recycled content are available.	.395	**.595**	.340
1.3 I believe that Recycled products have a long life.	.313	**.549**	.339
3.1 The price of recycled products is justified			**.838**
3.2 I believe that the price of recycled products fairly reflects their quality	.466		**.545**
3.3 I can afford to buy recycled products.		.312	**.421**

Each item's belonging to a factor is determined by the highest loading it has on that factor. Thus, the highest factor loading for each particular item is highlighted in bold.

3.4 Fidelity Analysis

In the final step, we labelled the three factors that emerged from the exploratory factorial analysis and calculated the internal consistency coefficient Alpha Cronbach for each scale (Table 8). Given the clustering of factors demonstrated by the statistical analyses, the factors were labelled according to the central theme of most items. All subscales have exceeded the critical threshold of 0.7, indicating that they have a high level of reliability.

Table 8. Final structure of the instrument.

Factor	Subscale	Alpha Cronbach	N of items
1	Perceived environmental benefits of recycled products	α =0.74	8
2	Perceived credibility of recycled products	α =0.83	6
3	Price perception of recycled products	α =0.78	3

4 Discussion

4.1 Implications and further research directions

Many organizations are currently contributing to global sustainability initiatives by producing recycled products. These efforts, however, will only be successful if consumers are willing to accept and purchase these products. As a result, consumer acceptance of recycled items is a critical aspect in assuring the success of circular business models. This work strengthens the theory in this body of literature by proposing and developing a measurement method in a context where most existing theories are centred on the antecedents of purchase intent [26-28].

Developing and testing an instrument to measure consumer acceptance of recycled products is an important undertaking from two points of view. Firstly, by developing measurement instruments with appropriate psychometric properties, empirical research can accurately capture the concept and use it in new conceptual models to develop new theories that address the gaps in the literature. Secondly, in practice, such tools can be integrated into market research and used to better understand consumers' motivations and interests towards recycled products, thus contributing to the effectiveness of marketing campaigns [29, 30].

Future research could also look into different research methodologies that focus on real-life buying behaviours to acquire a better knowledge of the actual purchase behaviour of products made from recycled materials. The current literature illustrates variety of research and experimental methodologies, yet all have certain limitations. For instance, a survey approach that require self-reports means that participants may be influenced by social desirability. Also, many articles using experimental designs used typical laboratory studies with condition randomization, which have great internal validity for testing the impact of specific interventions but lack external validity because they primarily focus on attitudes and hypothetical purchase willingness. However, field experiments that allow evaluating interventions in real-world settings with a higher external validity, have not been used so far to study this variable [31, 32].

4.2 Limitations

Exploratory factor analysis is not without drawbacks, despite the fact that it is an approach with significant methodological and statistical benefits. For instance, unlike regression analysis (the criterion), AFE cannot be assessed against an external criterion. Additionally, factor rotation is a procedure that creates numerous equivalent factor models, meaning that only the factor loadings of the items vary, not the explained variance. Last, labelling the factors might be challenging because certain traits may exhibit strong statistical correlations but lack evident justifications from the literature's perspective.

Furthermore, because instruments are frequently tested on a group that is not representative of the population being studied, they cannot be utilized to draw conclusions from the sample to the population. Such samples are beneficial when the goal of the research is to test a hypothesis or for pilot-testing, rather than validate the theory at the population level. It is important to emphasize, however, that this study instrument was designed for a pilot testing.

Despite its benefits, administering the questionnaire online also prevents any type of control over the respondent's environment, making it challenging to communicate in the event of concerns or solicitations of additional information.

5 Conclusions

Consumer acceptance of recycled items is a multifaceted variable that is now being extensively researched in the literature, frequently through interdisciplinary approaches. The examination of this topic must be continued in order to facilitate the implementation of the precepts of sustainable development and circularity at all levels of implementation. A decision-making model for the purchase of recycled items, for example, can contribute to the development of effective marketing campaigns, and understanding the variances attributed to socio-demographic differences can aid in the selection of the appropriate niche of potential clients. Such instruments can also be valuable for corporations conducting market research in order to launch their products in new places where their potential customers are not yet well-know.

This research also raises important considerations for policy makers. The government plays a significant role in promoting sustainable practices and circular economy concepts. As part of this, they can enact policies or provide incentives that encourage consumers to prefer recycled products. Consumer education and awareness programs can be launched to enhance understanding and acceptance of recycled goods. Such policy measures could significantly support businesses in their efforts to market recycled products effectively.

Theoretical constructs also need to consider the psychological factors that affect consumer acceptance of recycled products. Attitudes, beliefs, and perceptions play a crucial role in the acceptance of recycled goods. Thus, further research could delve into the cognitive processes underlying consumer decision making for recycled products.

Additionally, while understanding consumer acceptance of recycled goods is critical, organizations must ensure that their efforts to adopt circular business models do not negatively impact other aspects of their operations. Therefore, the implementation of circular economy practices must be balanced with the overall business strategy and should align with the broader corporate social responsibility initiatives.

Understanding consumer acceptance of recycled products and their contribution to the circular economy is critical. The successful implementation of sustainable development and circularity principles hinges on a multifaceted approach that considers the various stakeholders involved - from consumers and businesses to policymakers and researchers.

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