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Initial findings on COVID-19-induced changes to material consumption and mobility behavior

by:

Miriam Bodenheimer, Clemens Brauer, Johannes Schuler Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe

in collaboration with

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Abstract: Initial findings on Covid-19-induced changes to material consumption and mobility behavior

This paper presents the results of a multicountry survey on Covid-19-induced changes in consumption habits with a focus on nonessential material consumption and mobility behavior. The survey (n=4000) was carried out in Germany, Italy, Japan, and the United States in early 2021. Our findings show early trends toward more sustainable behavior in nonessential material consumption, especially a reduction in purchases and the realization, that the unpurchased items were not missed. While there were likewise significant pandemic-related changes in mobility both concerning trip frequency and purpose and transport modes, respondents' future intentions do not suggest significant gains in sustainability in this area.

Kurzbeschreibung: Erste Erkenntnisse über Covid-19-induzierte Veränderungen im Konsum- und Mobilitätsverhalten

In diesem Arbeitspapier werden die Ergebnisse einer länderübergreifenden Erhebung zu Covid-19-bedingten Veränderungen der Konsumgewohnheiten mit Schwerpunkt auf nicht lebensnotwendige Konsumgüter und dem Mobilitätsverhalten vorgestellt. Die Erhebung (n=4000) wurde Anfang 2021 in Deutschland, Italien, Japan und den Vereinigten Staaten durchgeführt. Die Ergebnisse zeigen erste Tendenzen zu einem nachhaltigeren Verhalten im Bereich nicht lebensnotwendiger Konsumgüter, insbesondere eine Reduzierung der Käufe und die Erkenntnis, dass die nicht gekauften Gegenstände nicht vermisst wurden. Während es ebenfalls signifikante pandemiebedingte Veränderungen in der Mobilität gab, sowohl in Bezug auf die Häufigkeit und den Zweck von Fahrten als auch auf die Verkehrsmittel, lassen die Zukunftsabsichten der Befragten keine signifikanten Gewinne an Nachhaltigkeit in diesem Bereich erwarten.

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SD Standard Deviation

Summary

This paper presents the results of a multicountry survey on changes in consumption habits with a focus on nonessential material consumption and mobility behaviors. The survey (n=4000) was carried out in Germany, Italy, Japan, and the United States in early 2021, between the second and third waves of Covid-19 in these countries. The sample was representative for age, gender, and household income. While many surveys were carried out in the early weeks and months of the pandemic, this work presents results gained after one year of the pandemic. Therefore, respondents had had some time to adjust to the new situation and new habits had already had an opportunity to become more permanent. The four chosen countries have had varied experiences with the severity of the pandemic as well as the governmental measures put in place in response.

Overall, our findings corroborate prior Covid-19 survey studies and show that some early trends toward more sustainable behavior in the area of nonessential material consumption can be recognized. The pandemic had noticeable effects on self-reported consumption patterns across all four countries. Between a quarter and more than half of respondents reported changes in their purchasing habits across all material goods categories. While in all four countries respondents reported an increase in purchases of online entertainment services, for the other consumption categories respondents reported fewer purchases, especially in the clothing and accessories category. Significantly, most of the people who purchased fewer material goods reported that they did not miss the items they had purchased regularly before the onset of the pandemic. Sustainability has increased in importance for many consumers. Both higher income and higher age increase respondents' likelihood of exhibiting sustainability-oriented purchasing behavior, whereas gender plays little of a role, except for the category of clothing.

The area of mobility likewise saw significant pandemic-related changes both concerning trip frequency and purpose and transport modes. Nevertheless, respondents' future intentions do not suggest significant gains in sustainability in this area. At the time of the survey, leisure trips and tourism showed the strongest decrease in frequency, followed by job/education-related trips. In all countries except the USA, a higher share of people started walking more, and bicycle use also increased. Although the use of shared modes of transportation plummeted, the use of private vehicles decreased as well. Concerning post-Covid-19 changes, however, an increase in mobility is likely for some trip purposes. Most respondents who predict a change in their mobility behavior want to travel more, especially for long-distance leisure trips. Respondents in some countries expected to walk and cycle more after the pandemic. However, these positive sustainability changes might still be offset by the relatively high percentages of respondents in all countries who expected to use private vehicles and planes more often.

Zusammenfassung

In diesem Arbeitspapier werden die Ergebnisse einer länderübergreifenden Umfrage zu nachhaltigkeitsorientierten Veränderungen der Konsumgewohnheiten mit Schwerpunkt auf nicht lebensnotwendige Konsumgüter und dem Mobilitätsverhalten vorgestellt. Die Erhebung (n=4000) wurde Anfang 2021 in Deutschland, Italien, Japan und den Vereinigten Staaten durchgeführt, also zwischen der zweiten und dritten Welle von Covid-19 in diesen Ländern. Die Stichprobe war repräsentativ in Bezug auf Alter, Geschlecht und Haushaltseinkommen. Während viele Erhebungen in den ersten Wochen und Monaten der Pandemie durchgeführt wurden, präsentiert diese Arbeit Ergebnisse, die nach einem Jahr der Pandemie gewonnen wurden. Dies bedeutet, dass die Befragten einige Zeit hatten, sich auf die neue Situation einzustellen, und dass neue Gewohnheiten bereits die Möglichkeit hatten, sich zu verfestigen. Die vier ausgewählten Länder haben unterschiedliche Erfahrungen mit der Schwere der Pandemie und den als Reaktion darauf ergriffenen staatlichen Maßnahmen gemacht.

Insgesamt bestätigen unsere Ergebnisse frühere Covid-19-Umfragestudien und zeigen, dass einige frühe Trends zu nachhaltigerem Verhalten im Bereich der nicht lebensnotwendigen Güter zu erkennen sind. Die Pandemie hatte in allen vier Ländern spürbare Auswirkungen auf die von den Befragten selbst angegebenen Konsummuster, wobei zwischen einem Viertel und mehr als der Hälfte der Befragten über Änderungen ihrer Kaufgewohnheiten in allen Kategorien von materiellen Gütern berichteten. Während die Befragten in allen vier Ländern einen Anstieg der Käufe von Online-Unterhaltungsdiensten meldeten, gaben sie für die anderen Konsumkategorien weniger Käufe an, insbesondere in der Kategorie Kleidung und Accessoires. Bezeichnenderweise gaben die meisten Personen, die weniger materielle Güter kauften, an, dass sie die Artikel, die sie vor Ausbruch der Pandemie regelmäßig gekauft hatten, nicht vermissten. Die Ergebnisse zeigen ebenfalls, dass Nachhaltigkeit für viele Verbraucher:innen an Bedeutung gewonnen hat. Sowohl ein höheres Einkommen als auch ein höheres Alter erhöhen die Wahrscheinlichkeit, dass die Befragten ein nachhaltigkeitsorientiertes Kaufverhalten an den Tag legen, während das Geschlecht – mit Ausnahme der Kategorie Kleidung – kaum eine Rolle spielt.

Während im Bereich der Mobilität ebenfalls deutliche pandemiebedingte Veränderungen sowohl bei der Häufigkeit von Wegen mit verschiedenen Wegezwecken als auch bei den Verkehrsmitteln zu verzeichnen sind, lassen die Zukunftsabsichten der Befragten keinen signifikanten Zuwachs an Nachhaltigkeit in diesem Bereich erwarten. Zum Zeitpunkt der Befragung war die Häufigkeit von Freizeit- und Tourismusreisen am stärksten zurückgegangen, gefolgt von berufs- und ausbildungsbezogenen Reisen. In allen Ländern mit Ausnahme der USA begann ein höherer Anteil der Menschen, mehr zu Fuß zu gehen, und auch die Fahrradnutzung nahm zu. Obwohl die Nutzung öffentlicher Verkehrsmittel im Nah- und Fernverkehr stark zurückging, nahm auch die Nutzung von Privatfahrzeugen ab. Was die Veränderungen nach Covid-19 anbelangt, so ist eine Zunahme der Mobilität für einige Wegezwecke wahrscheinlich. Die meisten Befragten, die eine Änderung ihres Mobilitätsverhaltens vorhersagen, wollen mehr reisen, insbesondere für Langstrecken-Urlaubsreisen. Die Befragten in einigen Ländern gingen davon aus, dass sie nach der Pandemie mehr zu Fuß gehen und mit dem Fahrrad fahren würden. Diese positiven Veränderungen in Bezug auf die Nachhaltigkeit könnten jedoch durch den relativ hohen Prozentsatz der Befragten in allen Ländern, die davon ausgingen, dass sie häufiger private Fahrzeuge und Flugzeuge benutzen würden, wieder ausgeglichen werden.

1 Introduction

The Covid-19-pandemic has been a unique event in that it almost simultaneously interrupted everyday life in nearly all countries across the globe. As a result, it created a worldwide natural experiment to examine the changes that such a massive global disruption can trigger. Viewed from this perspective, the pandemic has been a valuable opportunity for data collection on behavioral changes that take place when well-worn habitual behaviors can suddenly no longer take place due to immutable external circumstances. Economic shutdowns and social distancing led to countless changes in every practices (Echegaray 2021) and so unintentionally also "provided an opportunity to test a simpler lifestyle through consumption downsizing" (Cambefort 2020, p. 3). In this context, the disruptive nature of the pandemic was identified early on as a potential window of opportunity for a transition toward greater sustainability, especially with regard to consumption habits (Bodenheimer and Leidenberger 2020; Cohen 2020).

This paper presents the results of a multicountry survey on consumption habits with a focus on nonessential material consumption and mobility behaviors. The survey was carried out in Germany, Italy, Japan, and the United States in early 2021, between the second and third waves of Covid-19 in these countries.¹ While many surveys were carried out in the early weeks and months of the pandemic, this work presents results gained after one year. Therefore, respondents had had some time to adjust to the new situation and new habits had already had an opportunity to become more permanent. The four chosen countries have had varied experiences with the severity of the pandemic as well as the governmental measures put in place in response.

The paper is structured as follows: section 2 gives an overview of prior studies with a particular focus on those that likewise collected quantitative empirical data for material consumption and mobility behavior and included at least one of the countries surveyed. Section 3 describes the survey, including socio-economic and socio-demographic characteristics of respondents, as well as the limitations of this research. Section 4 presents comparative descriptive results between all four countries, as well as an in-depth analysis of the German data, focusing in particular on the influence of age, gender, and income on behavioral changes since the start of the pandemic. Section 5 concludes with a brief summary of the results.

¹ This paper presents the survey results with a focus on material consumption and mobility behaviors. The original study also included survey questions regarding food consumption and housing. A detailed description of these results through the lens of social practice theory can be found in Zollet et al. 2022.

2 Prior Studies

Figure 1 shows an overview of prior survey or consumer panel studies that have focused on changes in sustainability-related consumer preferences since the beginning of the Covid-19 pandemic across different countries. The overview lists studies in chronological order according to the point in time of each survey, which is particularly relevant for interpreting results in an ongoing crisis, where conditions change continuously and can thus significantly impact responses. Our own survey took place in February and March 2021, placing it between the Mastercard (2021) and Roland Berger GmbH (2021) data.

Next, the countries surveyed and the number of respondents are listed for each survey, as well as whether the inquiry was representative for certain characteristics or focused on a particular subgroup of the population. Germany, examined in six of the seven studies, and Italy, included in four studies, have been particularly well researched, whereas the USA and Japan were only included in two of these studies.

Figure 1: Overview of prior survey/consumer panel studies on changes in sustainabilityrelated consumer preferences since the start of the pandemic



Source: Fraunhofer ISI

Five of the studies included questions regarding consumers' overall attitudes toward sustainability and sustainable consumption (Hüttel and Balderjahn 2021; GfK 2021; Degli Esposti et al. 2021; Mastercard 2021; Roland Berger GmbH 2021). With the exception of Hüttel and Balderjahn (2021), all of these studies report a general increase in sustainability attitudes. The data by Hüttel and Balderjahn (2021) was the earliest, having been collected at the tail-end of the first Covid-19 lockdown in Germany, and found a decrease in consciousness of sustainable consumption and willingness to spend, as well as an increase in "shopping affinity", as compared to a prior survey in January 2020 among the same subgroup of sustainability-conscious consumers. Given the point in time of the data collection and the nature of the subgroup – i.e. persons already particularly aware of sustainability issues – these results are not surprising, perhaps reflecting a natural response to the shock and uncertainty of the early pandemic phase. This would match results found by Chae (2021), whose lab-based experimental data suggests

that the perceived threat from an infection is likely to decrease the preference for sustainable products among consumers.

The later studies, starting in the fall of 2020, show an overall increase in consumers' awareness of product sustainability and the impact of their own consumption habits (GfK 2021; Degli Esposti et al. 2021; Mastercard 2021). An increasing number of respondents has also begun to view sustainability as an important brand value, with 42 % of Germans, 35 % of Americans, 32 % of Italians, but only 13 % of Japanese considering sustainability a more important purchasing criterion after the pandemic than before (Roland Berger GmbH 2021). Similarly, Mastercard found that 32 % of Italians, 17 % of Americans, 16 % of Germans, and 9 % of Japanese "are likely to stop shopping from brands with no sustainability plans for the future" (2021, p. 38).

In terms of more specific changes in purchasing behaviors, most studies find an increasing trend towards shopping locally (GfK 2021; Degli Esposti et al. 2021; Mastercard 2021) or purchasing regional products (GfK 2021); only the data by Roland Berger GmbH stands in contrast, showing that "local origin has seen its significance erode" (2021, p. 8). The prior literature clearly indicates a decrease in product consumption across various retail sectors, including clothing, shoes, toys, and books (Cambefort 2020; Hodbod et al. 2021; Degli Esposti et al. 2021). In analyzing their multicountry, representative data in greater depth, Hodbod et al. (2021) found that women reduced their consumption more than men and younger households cut their retail consumption more than older households. The authors do not find a significant impact of income on changes in household consumption and conclude that "financial hardship is not the primary driver for reducing consumption" (Hodbod et al. 2021, p. 23). Degli Esposti et al. (2021) confirm that 53 % of their Italian sample decreased the purchasing frequency of clothing, while only 9 % increased it. In contrast, almost 50 % of respondents increased their purchasing frequency of entertainment products and services (books, films, series, video games), while only 8 % decreased it.

While the fear of infection played a major role in reducing in-person shopping and the wish to save money was a driver for reducing consumption in some countries, including Italy (Hodbod et al. 2021), a further significant motivation for this trend was consumers' realization that they simply did not miss the products they had previously purchased more frequently and began to buy only things they really needed (Gerold and Geiger 2020; Cambefort 2020; Hodbod et al. 2021; Degli Esposti et al. 2021).

Covid-19 not only had a significant impact on consumption, but also changed people's mobility behaviors. Consumption and mobility are deeply interlinked, as for many categories of consumption, mobility is an enabler (visits to stores, restaurants, places of public entertainment) and, in some cases, mobility may represent a form of consumption in itself (holiday travels, shared mobility services) (Cambefort 2020; Echegaray 2021; Degli Esposti et al. 2021; Hodbod et al. 2021; Hüttel and Balderjahn 2021). Additionally, the trend toward more or less local consumption impacts transport demand in the logistics sector (Cambefort 2020), although logistics is not within the scope of this study.

Two basic changes in mobility patterns could be observed during the Covid-19 pandemic: an overall reduction of mobility, i.e. fewer and shorter trips were made, and a modal shift from public transportation toward the use of private cars or active mobility (walking and cycling).

The extent of both can be estimated by the analysis of GPS data or other methods of traffic count.² Therefore, the focus of scientific literature on the effects of the Covid-19 pandemic on mobility is on which factors influence the current changes in mobility patterns, and how persistent those changes will be in the future. In Figure 2, we give an overview of the literature reviewed for this paper.





Source: Fraunhofer ISI

Using different methodologies, Bonaccorsi et al. (2020), Engle et al. (2020), Anke et al. (2021), Mahajan et al. (2021), Ando et al. (2021), and Kolarova et al. (2021) all confirmed that people across various countries reduced their mobility during the Covid-19 crisis. Bonaccorsi et al. (2020) found a stronger reduction in traffic performance³ in municipalities with low average individual income and high income-inequality, as well as municipalities with higher fiscal capacity⁴. Engle et al. (2020) put mobility data in relation to the daily reported number of confirmed Covid-19 cases for 3142 counties in the USA and found a positive correlation between mobility rate and infection rate, suggesting that greater mobility leads to higher infection rates. They also found a negative correlation between mobility rate and the existence of a government

² Examples for freely available traffic data are: Google (https://www.google.com/covid19/mobility/), Apple (https://covid19.apple.com/mobility) and with a significant delay the statistical pocketbook "EU transport in figures" (https://op.europa.eu/en/publication-detail/-/publication/14d7e768-1b50-11ec-b4fe-01aa75ed71a1).

³ Accumulated distance covered within a certain spatial unit and time span

⁴ Unit used by the Italian Ministry of Economy and Finance to measure the independence from transfers by the central government

restriction order, implying that those orders do reduce mobility as intended. Other factors promoting a mobility reduction were higher shares of population over 65 years of age, lower percentages of votes for the Republican Party, as well as higher population densities. Anke et al. (2021) pointed out that the number of recreational and job-related trips declined drastically as compared to before the pandemic. Ando et al. (2021) found that people reduced shorter trips more often than longer ones.

With regard to mode choice, Anke et al. (2021), Hüttel and Balderjahn (2021), Hodbod et al. (2021), and Kolarova et al. (2021) all confirmed a decrease in the use of public transportation, including air travel. At the same time, Anke et al. (2021), Kolarova et al. (2021), and Nobis et al. (2022) see an increase in driving by car and active mobility. Anke et al. (2021) found that regular users of public transport are mostly responsible for this modal shift, while users of other transport modes primarily maintained their mode choice from before the pandemic. They found no major differences between areas with or without local lockdown. The modal shift had a similar pattern in rural and urban regions, but was more pronounced in the latter (Anke et al. 2021). Hodbod et al. (2021) and Nobis et al. (2022) identified fear of infection as the main reason for this shift away from public transport. In their altogether five surveys throughout the course of the pandemic, Nobis et al. (2022) show that the shift from public transport to the private car established itself as a stable change of attitude.

In their study in a German rural area, König and Dreßler (2021) found that mobility was not equally reduced among all respondents, with some reporting no reduction in mobility. The expected long-term effects of pandemic-induced mobility changes were rather low, with respondents expecting only a slight increase of bicycle use and a somewhat stronger decrease in air travel. It should be noted that almost all of the mobility studies collected their data in the first few months of the pandemic. With the exception of Ando et al. (2021) and Nobis et al. (2022), few new studies using empirical data have been published since.

3 Data and Methodology

3.1 Survey administration and sample characteristics

The survey (n=4000) was administered by Respondi in each of four countries, Germany, Italy, Japan and the USA, in February and March of 2021 (see Table 1). Looking back, the survey timing for all countries was in the brief space between the winter 2020/2021 and spring 2021 Covid-19 waves. The sample included 1000 people from each country, selected among respondents aged 18+ living in the country and with internet access. The sample was representative for age, gender, and household income. Detailed socio-demographic characteristics of the respondents can be found in Table 2, as well as socio-economic characteristics in Table 3.

Country	Survey period	Government Response Stringency Index at the time of survey administration (strictest response = 100)	Ranking (strictest = 1st)
Germany	March 10 – March 12, 2021	77.78	12th
Italy	March 10 – March 15, 2021	84.26	10th
Japan	March 5 – March 15, 2021	45.37	123rd
USA	February 25 – March 7, 2021	66.21	57th

Table 1: Survey administration

Source: Government Response Stringency Index, Our World in Data

Table 2:Survey socio-demographic characteristics of the sample

	Mean	SD	Min	Max	Mean	SD	Min	Max	
		A	ge		Household size (people)				
Germany	48.01	16.40	18.00	83.00	2.48	3.12	1.00	8.00	
Italy	47.11	15.60	18.00	85.00	3.01	1.20	1.00	9.00	
Japan	46.07	16.80	18.00	90.00	2.61	2.28	1.00	7.00	
USA	44.10	15.30	18.00	85.00	2.88	2.75	1.00	10.00	
	Но	usehold: ch	ildren age 6-	-18	Hou	sehold: child	lren under a	ge 6	
Germany	0.35	0.69	0.00	3.00	0.16	0.44	0.00	3.00	
Germany Italy	0.35 0.42	0.69 0.71	0.00 0.00	3.00 3.00	0.16 0.15	0.44 0.43	0.00	3.00 4.00	
Germany Italy Japan	0.35 0.42 0.30	0.69 0.71 0.66	0.00 0.00 0.00	3.00 3.00 5.00	0.16 0.15 0.22	0.44 0.43 0.53	0.00 0.00 0.00	3.00 4.00 3.00	

Source: Fraunhofer ISI

		Germany	Italy	Japan	USA
×	Female	504	501	500	503
Š	Male	496	499	500	497
	Employed full-time	39 %	40 %	42 %	42 %
sn	Employed part-time	15 %	11 %	19 %	11 %
t stat	Self-employed	6 %	9 %	6 %	6 %
ment	Looking for a job	6 %	13 %	5 %	10 %
yolqr	Retired	25 %	16 %	12 %	13 %
E	Disabled or not able to work	3 %	0 %	3 %	7 %
	Not employed and not looking for a job	7 %	11 %	12 %	10 %
e	My status hasn't changed.	63 %	58 %	52 %	57 %
chan	I am temporarily working fewer hours than before	15 %	18 %	14 %	11 %
t status	I am working fewer hours than before and expect this change to be permanent	5 %	6 %	9 %	7 %
/men	I am working more hours than I did before	8 %	9 %	4 %	9 %
nploy	I lost my job/had to close my own business	5 %	5 %	4 %	11 %
Ъ	Other	5 %	4 %	18 %	5 %
	improved significantly	1%	0 %	1%	6 %
ation	improved slightly	11 %	6 %	5 %	14 %
situa	stayed the same	55 %	50 %	57 %	47 %
incial	gotten worse	22 %	30 %	25 %	23 %
Fina	gotten significantly worse	10 %	13 %	12 %	10 %
	I don't know or prefer not to answer	1%	0 %	1%	1%
u	I continue to work where I worked before the COVID-19 pandemic	56 %	56 %	72 %	62 %
k locatio	I am now partially teleworking and partially working outside the home	22 %	24 %	16 %	13 %
Wor	I am now teleworking exclusively	19 %	15 %	6 %	16 %
	Other	4 %	5 %	6 %	9 %
6 e	Yes	20 %	23 %	6 %	38 %
ovid-1 ositiv	No	80 %	77 %	94 %	62 %
Ϋ́α	prefer not to answer	0 %	0 %	0 %	0 %

Table 3: Socio-economic and demographic characteristics of the sample

Source: Fraunhofer ISI

Table 3 shows that Italy and the USA included the highest percentage of respondents looking for a job at the time of the survey, and that, in comparison to the other three countries, more than twice as many Americans had lost their job or had to close their own business as a result of the pandemic. At the same time, American respondents were also most likely to report an improvement in their financial situation (20 %), while a staggering 43 % of Italians reported some degree of worsening in their financial situation.

Almost three-quarters of Japanese respondents reported that their work location had not changed as a result of Covid-19, whereas 39 - 41 % of German and Italian respondents reported some degree of teleworking as a result of the pandemic. 38 % of American respondents reported that they or someone they care about had been tested positive for Covid-19, while this only applied to 6 % of Japanese respondents.

3.2 Data analysis and interpretation

To analyze the survey data, we performed both descriptive and regression analyses. Section 4.1 presents a descriptive comparison of the data across all four countries and highlights overarching trends that can be seen. We analyzed the data for Germany in greater depth in Section 4.2. In addition to the descriptive analyses, we calculated several correlations (Pearson's r, Cramer's phi) between changes in purchasing behavior and gender, age and income, as well as a worsening financial situation and Covid-19 exposure. Moreover, we used t-test to compare differences between groups such as younger vs. older respondents as well as males vs. females. The test statistic indicates whether a discovered difference in the mean values between two groups is statistically significant. As a result of the large sample size (n = 1000), many results were statistically significant (p < 0.05) without being meaningful. The results presented here are those that were both significant and judged to be meaningful and relevant, i.e. had a medium or large effect size (e.g. Pearson's *r* greater than 0.1).

We also performed binary logistic regression analyses to examine the influence of gender, age, and income as predictors of changes in sustainability-related consumption behaviors. The basis of the analysis was the following question:

With regard to the discretionary material goods you purchase, have you made any of the following changes to your habits since the start of the Covid-19 pandemic?

- purchased more organic clothing
- purchased more fair trade clothing
- made my own clothing
- purchased more locally/regionally produced goods
- purchased more from local stores
- looked for goods with a long lifespan
- looked for goods that are easy to repair
- looked for goods with minimal plastic packaging
- looked for environmentally sustainable goods
- looked for socially sustainable goods

For each of these habit changes, respondents could choose from the following responses: (1) did not make this change; (2) tried this change but stopped; (3) tried this change and continue today; (4) was already doing this before; (5) plan to make this change in the future. For the logistic regression, we created a binary response variable, where 0 was "does not engage in habit" (responses 1 & 2) and 1 was "engages in habit" (responses 3 and 4). Response 5 was left out of the regression.

In the mobility section, we performed a Pearson's *r* analysis in order to see how changes in cycling, walking, and the use of public transport and private car during the pandemic correlated with plans concerning mode choice after the pandemic. Additionally, we evaluated the influence of gender, age, and income on pandemic-caused changes in mode choice and frequency of trips with certain purposes in a linear regression. In line with the consumption section, we performed binary logistic regression in order to analyze the influence of gender, age, and income on the answers concerning drivers and barriers for a more sustainable mobility after the pandemic.

3.3 Survey limitations

The results presented in the next section should be interpreted in light of the methodological limitations of the survey, which can be divided into two categories. First, there are the general limitations of this type of survey: its online administration implies that certain demographics are harder to reach than others, for example older generations or households without reliable internet access. Moreover, self-reported answers are always subject to some degree of social desirability bias, which can be expected to be the case in this survey as well.

The second category of limitations is more specific to this particular survey: both our survey and the ones we referenced in the prior section are only snapshots of one particular moment in time. While this is true for any survey, it holds particular importance in the midst of an ongoing crisis event like a pandemic, where conditions are constantly changing, including the severity of the current infection rate and the counter-measures in place in any particular country at that moment in time. Since these conditions have a strong impact on people's everyday behavior, the results of this survey need to be interpreted as being representative of the particular moment in time when the survey took place, i.e. the spring of 2021. In the future, the results might change as a result of the continued evolution of this fluid situation. Similarly, our survey covered four different countries, each with its own unique experience of the pandemic. While the ability to compare between countries is one of the explicit strengths of this research, readers should keep in mind that each country has not only different cultural and geographical baselines independent of the pandemic, but also experienced different infection and death rates, countermeasures, as well as political and media messaging, all of which may have impacted people's responses to the survey questions.

4 Results

4.1 Descriptive comparison between countries

4.1.1 Changes in purchasing habits of material goods

In order to assess changes in material consumption during the Covid-19 pandemic, respondents were first asked to what degree they had regularly consumed certain goods prior to the pandemic.

Figure 3 shows a self-reported pre-pandemic baseline of consumption regularity. Noticeably fewer Japanese respondents purchased material goods regularly before the pandemic as compared to the other three countries, whereas Italians were most likely to regularly purchase these items, with the exception of online entertainment services, where the USA was in the lead. In all countries, clothing & accessories were most likely to be purchased regularly prior to the pandemic, with more than 50 % of Japanese and between 76 % and 83 % of Germans, Americans, and Italians making regular clothing purchases.



Figure 3: Purchases made regularly prior to Covid-19 pandemic

N = 1000 per country, multiple answers allowed Source: Fraunhofer ISI

Before the pandemic, Germans were most likely to report sustainable behavior, with more than 50 % of Germans looking for products with a long lifespan, 46 % valuing goods with minimal plastic packaging and 39 % preferring products that can easily be repaired (Figure 4). Germans were also most likely to look for goods that are socially or environmentally sustainable and purchase fair trade or organic clothing. In Japan, the regional/local focus was particularly strong pre-Covid-19, with 26 % of respondents reporting an effort to purchase goods from local stores and 21 % preferring locally or regionally produced goods.





N = 1000 per country, multiple answers allowed Source: Fraunhofer ISI

The pandemic had noticeable effects on self-reported consumption patterns across all four countries, with between a quarter and sometimes more than half of respondents reporting changes in the amount of purchases made across all material goods categories (Figure 5). Changes were particularly dramatic in Italy and the US, where almost half of respondents in every category reported a change in their purchasing behavior. Japanese respondents reported the fewest changes.

The category clothing & accessories showed the most significant changes, with 70 % of Italians, 55 % of Germans, 45 % of Americans and 41 % of Japanese reporting fewer purchases during Covid-19 than before, matching prior findings (Degli Esposti et al. 2021; Hodbod et al. 2021). In Italy, the USA and Germany, approximately a third of respondents purchased fewer electronic devices than before, while in all four countries, more respondents reported an increase in purchasing online entertainment services than reported purchasing less, as was also the case in Degli Esposti et al. (2021).

Changes in purchasing habits during the pandemic were not only limited to the amounts that were purchased of each type of good, but also to products' sustainability characteristics. With in some cases up to a quarter of respondents, Italians were most likely to try new, sustainability-oriented practices during Covid-19 and are also most likely to continue them into the present, whereas the Japanese were least likely to try such new practices (Figure 6). This matches the results reported by Mastercard (2021), which found that Italians have a much higher awareness of their environmental impacts and find it more important to reduce their carbon footprint than respondents from the other three nations. Comparing the different sustainability categories, people across all four countries were most likely to look for goods with a long lifespan, minimal plastic packaging, or that can easily be repaired. Regarding overall sustainability, approximately 15 % of Germans, 21 % of Italians, 9 % of Japanese and 14 % of Americans began to look for environmentally and socially sustainable goods and continue this practice into the present.

Across all categories and countries, most people who tried sustainability-oriented changes report continuing them into the present, rather than abandoning them again.





N = 1000 per country Source: Fraunhofer ISI



N = 1000 per country

*The answer categories "was already doing this", "did not make this change", and "plan to make this change in the future" were included in the question, but are left out here for better clarity and focus on the answers that are of interest here. Source: Fraunhofer ISI

While many people **purchased fewer material goods** during Covid-19, most of them did not miss the items they had purchased regularly prior to Covid-19 (Figure 7). This corroborates findings by Hodbod et al. (2021), Degli Esposti et al. (2021), and Cambefort (2020). In Germany, for some items as many as 80 - 90 % of those respondents who purchased fewer goods reported not missing these items.

Figure 7: Do you miss the items you have purchased less since the start of the COVID-19 pandemic?



For those who purchased less in each category (see Figure 5).

N = Variable by item and country; Germany: N \ge 47; Italy: N \ge 115; Japan: N \ge 72; USA: N \ge 108 Source: Fraunhofer ISI



Figure 8: Planned changes for the future

N = 1000 per country, multiple answers allowed Source: Fraunhofer ISI

Similar amounts of people to those who already changed their material consumption plan on making such changes in the future (Figure 8). However, it is unclear how many of these "good intentions" will actually result in lasting changed behavior.

For those who **did not make changes**⁵ **in their sustainability-related practices**, "Just not interested or don't need such a product" was by far the most common response. It accounted for between 29 % and 64 % of responses, depending on country and item. While it was always the

⁵ See question 5 in the appendix for all possible answers. Respondents were asked to check all answers that applied for all questions regarding barriers and motivations (questions 4-7).

most frequently selected response, averaging across all products and characteristics, there was a clear difference in the importance of lack of interest or need between the countries:

- ▶ USA: 61 %
- Japan: 57 %
- ▶ Italy: 46 %
- ▶ Germany: 39 %

These numbers suggest that the overall interest in more sustainable products and practices appears to be greater in the two European countries than in the USA and Japan. Thereafter, people most commonly checked "Other" followed by "New goods were too expensive".

For those respondents who **tried a change but stopped**, goods being too expensive was the most common reason, followed by the change requiring too much labor, energy, or time. For those who **tried a change to their practices and continue today**, conformity with personal values is the most important enabler or motivator for change, followed by the ability to purchase a product locally and the feeling that the new practice is a better value for one's money.

4.1.2 Changes in repair behavior

Respondents were further asked if items from the different consumption categories had broken since the start of the Covid-19 pandemic and if so, if they repaired the item or had it professionally repaired (Figure 9).



Figure 9: Have you repaired broken items or did you have them repaired?

(For those who reported at least one broken item)

N = Variable by item and country; Germany: N \ge 310; Italy: N \ge 310; Japan: N \ge 180; USA: N \ge 330 Source: Fraunhofer ISI

Just over half of Italians (51.4 %) reported that their item was repaired, either professionally or by them. Germans likewise showed a great propensity for repair, at a total of 40.4 %. Americans (33.7 %) and Japanese (28 %) were much less likely to repair their items, with the Japanese

being the most willing to replace (38.5 %) or throw out (33.6 %) broken items. However, Japanese respondents also reported significantly less frequently that items had broken in the first place (22 % in Japan vs 35 - 39 % in the other three countries). A quarter of German and Italian respondents reported that they would also have repaired the item before the pandemic, as opposed to only 12 - 15 % of Japanese and American respondents. At 12.7 %, Italians were also the most likely to try repairing items they would not have fixed themselves prior to Covid-19.

With regard to why people repaired items themselves, the most important motivation for respondents in the USA and Japan was to save money (Figure 10). German respondents cited environmental protection as the most important motivator, while Italians (and many Germans) were most likely to repair items themselves because they enjoyed it as an activity.



Figure 10: What do you feel motivated and/or enabled you to perform the repair yourself?

N = Variable by item and country; Germany: N \ge 10; Italy: N \ge 20; Japan: N \ge 5; USA: N \ge 21, multiple answers allowed Source: Fraunhofer ISI

In terms of barriers, Germans (39 %), Italians (36 %), and Americans (39 %) were most likely to feel that an item was simply not worth repairing, while the Japanese most often preferred to purchase a new item with new or better functions (40 %). The second most common reason in all countries was not knowing how to repair the item by themselves. A lack of space for repair was the least common barrier reported across all countries (Figure 11).





(For those whose item was not repaired (by them or professionally))

N = Variable by item and country; Germany: N \ge 44; Italy: N \ge 65; Japan: N \ge 43; USA: N \ge 102, multiple answers allowed Source: Fraunhofer ISI

4.1.3 Changes in mobility behavior

In order to allow a quantitative assessment of changes in mobility behavior, we first asked respondents about their use of different transport modes before the pandemic. The results are displayed in Figure 12. Walking is far more common in Germany and Italy than in the other two countries, while cycling and public transport are common (over 30 %) in all countries except the USA. Car ownership and usage are less common in Japan than in the other countries. Altogether, there were stronger similarities in the self-reported regular usage of different transport modes between Germany, Italy, and Japan compared to the USA. It attracts attention that German and Italian respondents on average use more transport modes on a regular basis (2.5 modes) than Japanese (2.0 modes) and US-American respondents (1.6 modes).



Figure 12: Which modes of transportation did you use at least once per week before the COVID-19 pandemic?

N = 1000 per country, multiple answers allowed Source: Fraunhofer ISI

Due to the Covid-19 pandemic, trip frequency decreased rapidly, as also reported in all studies named in chapter 2, though to a different extent depending on trip purpose. The modal share also changed. The highest reduction of trip frequency for all purposes except shopping and errands was observed in Italy, whereas in Japan, the respondents reported the lowest reduction. This reflects the highest lockdown stringency in Italy and the lowest stringency in Japan. The trip purposes that were subject to the strongest decrease in frequency were leisure trips and tourism (up to -85 % for both categories in Italy). Concerning trips for job, education and shopping/errands, 30 - 40 % of the respondents reported a reduced frequency, which is in line with the findings of Anke et al. (2021) as seen in Figure 13. A large share of them dispensed with their job/education-related trips completely.





N = 1000 per country

Source: Fraunhofer ISI

Figure 14: How has your use of the following transportation modes changed since the COVID-19 pandemic?



N = 1000 per country Source: Fraunhofer ISI

The survey also assessed changes in the modal split (Figure 14). In all countries except the USA, the share of respondents who increased walking during the pandemic was higher than the share of those who reduced it due to an overall reduction of trips. This is in line with Anke et al. (2021). Germany (+42 %) and Italy (+39 %) are the countries where this trend was especially pronounced. In Germany, respondents reported the highest increase in cycling (+21 %). At the same time, all shared or public modes of transportation lost a vast portion of their passengers, as already reported by Anke et al. (2021), Hüttel and Balderjahn (2021), and Hodbod et al. (2021).

The usage of private vehicles decreased significantly as well, but not to the same extent as shared or public mobility. In all four countries, the percentage of those traveling less by car exceeds that of those driving more during the pandemic. This seems to contradict the findings of Anke et al. (2021), who reported a higher share of people traveling by car. Nevertheless, a higher share of car travel in total mobility can still mean a reduction in trip frequency, if the total number of trips declined.

Figure 15: To which extent will the frequency of your trips with the following purposes have changed after the end of the COVID-19-related constraints, compared to the time before the COVID-19 pandemic?



N = 1000 per country Source: Fraunhofer ISI





N = 1000 per country Source: Fraunhofer ISI

Looking at expectations for the time after the pandemic, respondents paint a rather diverse picture of how they intend to conserve the changes in their mobility behavior (Figure 15). In all countries, they predict a decrease in job and education-related mobility in comparison to the pre-Covid era significantly more often than an increase, especially in Italy. A possible reason for this might be the increased acceptance for remote work and online meetings, as indicated in Table 3. Concerning trips for errands, leisure and tourism, respondents anticipated an increase in frequency after the pandemic, especially for vacations and long-distance trips (between 33 % and 43 %).

Concerning the modal split (Figure 16), more than 20 % of Italian and German respondents seem to have enjoyed walking and cycling and plan to do this more after the pandemic than before. Less sustainable, however, is the significant share of Italian, German, and US-American respondents who plan the same thing for the usage of their private car. The prospected post-Covid development of local and long-distance public transportation is less clear. While a higher percentage of German and Japanese respondents expect to use them more often than less often, the opposite was true in Italy and the USA. For Germany, Nobis et al. (2022) in the meanwhile found out that the trends of more car usage and less usage of public transport has stabilized.



Figure 17: Why do you suppose that your mobility behavior will be different after the end of COVID-19-related constraints than before?

N = Variable by country; Germany: N = 671; Italy: N = 719; Japan: N = 595; USA: N = 602, multiple answers allowed Source: Fraunhofer ISI

Asked for the reasons for these changes in their mobility behavior (Figure 17), more than 20 % of respondents in all countries mentioned studying and working from home as a major reason for their planned mobility changes in the time after the pandemic. In contrast, 5 % - 9 % reported a permanent reduction of working hours, and 5 % - 11 % lost their job or business (Table 3). In Germany and Italy, more than 20 % of the respondents predict that they will make shorter leisure trips after the pandemic, because they have learned to appreciate regional recreation areas. Even more respondents in these three countries plan to reduce trips by

combining different errands (Germany 41 %, Italy 28 %, USA 37 %). Only Japanese respondents did not prefer to make shorter trips or spend their leisure more locally to the same degree. In contradiction to this trend, a high share of respondents plans to increase their number of trips, because it would make them happier (between 37 % in Germany and 25 % in Japan).





N = 1000 per country, multiple answers allowed Source: Fraunhofer ISI

In all countries respondents named hygiene measures as an important factor to motivate them to use public transport (again) after the pandemic. This is absolutely in line with Nobis et al. (2022) who found out that people feel more comfortable in their cars and less comfortable in public transport vehicles since the beginning of the pandemic. Only in Germany, lower fares are prioritized even more. The overall willingness to use public transport, however, differs significantly between the four countries, approximately mirroring the pre-Covid status of public transport in the respective countries (Figure 12). In the USA, almost half of respondents stated that they were not using public transportation before the pandemic and were not planning to do so after, while in Japan the willingness is the highest (Figure 18).

Similarly, with regard to bicycle use, more than one out of two American respondents stated that they had not used a bicycle before the pandemic, nor would they after. This is considerably more than in the other countries. In all countries, heavy car traffic and lack of infrastructure are major reasons that prevent respondents from planning to cycle more after the pandemic (Figure 19).





N = 1000 per country, multiple answers allowed Source: Fraunhofer ISI

4.2 In-depth analysis of German data

We examined the data from German respondents in more detail to analyze whether different parameters had an influence on survey responses or how different observed or planned behavioral changes are interconnected⁶. The applied statistical methods were t-test⁷, Pearson's r⁸, Cramer's V (ϕ)⁹ as well as linear regression tests¹⁰.

4.2.1 Changes in purchasing habits of material goods

We examined the data from German respondents in more detail to analyze whether gender, age, or income had an influence on survey responses. In a first step, we calculated Pearson's r and Cramer's V (ϕ) as a measure of correlation between the three demographic variables and respondent's changes in purchasing frequency during the Covid-19 pandemic¹¹. Similar to Hodbod et al. (2021), we found that men reduced their consumption of clothing and accessories during the pandemic slightly less strongly than women¹², although both groups reported a reduced consumption during the pandemic (Figure 20). Our results also showed that the older

 $^{12} M_{male} = 1.56, M_{female} = 1.43; t(998) = 3.36$

 $^{^{6}}$ Only statistically significant results are reported. If not stated otherwise, all results are significant within a confidence interval of p <= 0.01. Exeptions with p <= 0.05 or p <= 0,1 are indicated with two asterisks (**) or one asterisk (*), respectively. Detailed output tables are available upon request.

⁷ A t-test is a statistical method used to compare mean values. It examines how likely it is that the differences in means between two groups happened by chance.

⁸ The Pearson's r is interpreted as follows: r >= $0.1 \triangleq$ weak correlation, r >= $0.3 \triangleq$ moderate correlation, r >= $0.5 \triangleq$ strong correlation.

⁹ The Cramer's V (φ) is interpreted as follows: $φ \ge 0.1 \triangleq$ weak correlation, $φ \ge 0.3 \triangleq$ moderate correlation, $φ \ge 0.5 \triangleq$ strong correlation.

¹⁰ The standardized correlation coefficient β is interpreted as follows: $\beta \ge 0.1 \doteq$ weak correlation, $\beta \ge 0.3 \doteq$ moderate correlation, $\beta \ge 0.5 \triangleq$ strong correlation.

¹¹ For the following mean values (*M*), 1 = purchased less, 2 = purchased the same amount, 3 = purchased more than before the pandemic.

half of respondents (above 49 years) were more likely to reduce their average online entertainment consumption than the younger half of respondents (below 49 years)¹³ (Figure 21). Similarly, younger people reduced their consumption of books, CDs, and DVDs during the pandemic to a smaller amount than older people (Figure 22)¹⁴.



Figure 20: Purchasing habits of clothing and accessories during the Covid-19 pandemic

With regard to socio-economics, income had an impact on two consumption categories: the lower the income, the more people reduced their consumption of children's toys and online entertainment services during the pandemic¹⁵.



Figure 21: Purchasing habits of online entertainment services during the Covid-19 pandemic

N = 1000; The sum of all responses is 100 %; since the survey was representative for age, the age groups are not divided evenly but rather in accordance with their share in the population. Source: Fraunhofer ISI

N = 1000 Source: Fraunhofer ISI

 $^{^{13}\,}M_{<49y}=2.13,\,M_{>49y}=1.89;\,t(998)=6.65$

¹⁴ $M_{<49y} = 1.95$, $M_{>49y} = 1.84$; t(998) = 3.07

¹⁵ *r*_{toys} = 0.145**; *r*_{online entertainment} = 0.130

Moreover, we found a weak positive correlation between a worsening financial situation during the pandemic and a reduction in purchasing of clothing, electronics, and books, CDs, and DVDs.¹⁶ We also tested for but did not find relevant correlations between changes in purchasing habits and Covid-19 exposure.



Figure 22: Purchasing habits of books, DVDs & CDs during the Covid-19 pandemic

N = 1000; The sum of all responses is 100 %; since the survey was representative for age, the age groups are not divided evenly but rather in accordance with their share in the population. Source: Fraunhofer ISI

In a second step, we ran a binary logistic regression with gender, age, and income as predictors for sustainability-related changes in purchasing habits since the start of Covid-19. We found that gender only had an effect in one instance: at the time of the survey, men were 42.3 % less likely to be purchasing organic clothing than women.

With regard to income, an increase in income from one category to the next¹⁷ increased the probability of respondents purchasing organic clothing at the time of the survey by 23.2 % (**); fair trade clothing by 17.8 % (**); locally/regionally produced goods by 17.1 %; environmentally sustainable goods by 18.2 %; and goods with minimal plastic packaging by 15.1 % (**).

Age likewise had an impact on several habits. An increase in age by one year increased the probability of respondents purchasing locally/regionally produced goods at the time of the survey by 1.6 %; from local stores by 1.9 %; goods with a long lifespan by 1.1 % (**); goods that are easy to repair by 1.7 %; and environmentally sustainable goods by 1.0 % (**).

4.2.2 Changes in mobility behavior

Taking a closer look at the German data, we first examined correlations between mobility behaviors during the pandemic and mobility-related plans for the post-Covid future. We found that respondents from the German dataset who increased their cycling trips during the pandemic plan to do so after. Respondents, who tried out walking during the pandemic, plan to continue doing so as well¹⁸. Considering that a large share of respondents increased walking and

 $^{^{16}}$ $\phi_{clothing}$ = 0.132,; $\phi_{electronics}$ = 0.099,; $\phi_{books,\ CDs\ \&\ DVDs}$ = 0.125

¹⁷ For the analysis, the responses were divided into quartile categories of <2.000€, 2.000-3.000€, 3.000-4.000€ and >4000€.

¹⁸ $r_{cyclcling-cycling} = 0.469$; $r_{walking-walking} = 0.323$

cycling at the same time¹⁹ it is no surprise that pandemic cyclists also plan to walk more after the pandemic than before and vice versa²⁰. Another notable fact is that respondents who increased cycling during the pandemic plan to increase their usage of all other means of transport²¹, while this correlation is not visible for those who walked more.

Shifting attention away from micro-mobility to motorized mobility, we found that respondents who used their private vehicle more than before the pandemic plan to keep this up after. Respondents who increased public transport usage almost show the same persistence²². At the same time, respondents who used public transport less during the pandemic than before, instead increasingly used their private vehicle²³. In this context, it seems contradictory that respondents who used public transport less, do not plan to use a private vehicle significantly more than those who did not.

In the next step, in a multinomial linear regression, we looked for the interdependencies of the reported and planned mobility changes with the respondents' gender, age, and income. We found that women reduced their business and official trips by 9.5 % less than men but at the same time reduced their shopping trips and errands by 9.5 % and leisure trips by 11.0 % more. A reason for this might be the traditional role many women still play within their families. For the time after the pandemic, women plan to increase their leisure trips by 12.9 % and vacations by 12.1 % more than men. Regarding the effects of age, we found that respondents reduced their trips for work or education by 0.6 % less for every extra year of life, business travels by 0.4 % less, and car trips (for all purposes) by 0.2 % (**) less. Respondents also reduced their business and leisure trips, as well as their air travel, more with higher income. One possible explanation for this effect is that respondents with a higher income traveled more before the pandemic and therefore also reduced their trips more strongly.

The last aspect we analyzed is whether respondents' reaction to barriers and drivers for sustainable mobility depends on gender, age, and income. We found that respondents' plans to work and study from home increase with increasing income²⁴ and even more with younger age²⁵. Likewise, video conferences as a substitute for business trips are regarded as more relevant the younger the respondents are²⁶ and the higher their income²⁷. Video conferences also seem to be more relevant for men than for women²⁸. A possible reason for this might be that these groups are more likely to work in office jobs without direct contact to customers, which is an enabler for teleworking. Additionally, students whose classes were replaced by online sessions are mostly located in the younger groups. With regard to leisure trips, older respondents have discovered a stronger preference for local recreation areas than younger ones²⁹. Respondents with a lower income indicated to a much higher extent that their change in mobility patterns derives from drastic changes in their financial³⁰ and/or personal situation³¹. The share of respondents who reported a drastic change in their personal situation is significantly higher in the youngest age group³² (Figure 23 and Figure 24).

- $^{24}r = 0.131$
- $r^{25} r = -0.252$
- $r^{26} r = -0.148$ $r^{27} r = 0.193$
- 27 r = 0.193 28 r = -0.124

 $^{^{19}}$ r = 0.410

²⁰ $r_{cycling-walking} = 0.195$; $r_{walking-cycling} = 0.237$

²¹ Private vehicle ($\varphi = 0.100$ **), shared and unshared transport services ($\varphi = 0.148$), local public transport ($\varphi = 0.140$), long distance public transport ($\varphi = 0.122$), airplane ($\varphi = 0.100$)

²² $r_{driving-driving}$ = 0.245; $r_{public-public}$ = 0.173

 $^{^{23}}$ r = 0.124

 $^{^{29}}$ r = 0.124 29 r = 0.175

 $^{^{30}}$ r = -0.212

 $^{^{31}}$ r = -0.163

³² r = -0.108 **







N = 671, multiple answers allowed Source: Fraunhofer ISI



Figure 24: Income and drivers for sustainable mobility

N = 671, multiple answers allowed Source: Fraunhofer ISI





N = 1000, multiple answers allowed

Source: Fraunhofer ISI

A look at drivers and barriers for the usage of bicycle and public transport reveals a very interesting insight: almost all items that represent an improvement in the attractiveness of those transport modes were chosen significantly more by younger respondents. In contrast, the items "I did not use public transport before the COVID-19 pandemic nor will I after"³³ and "I did not use a bicycle before the COVID-19 pandemic nor will I after"³⁴ were chosen more often with higher age. Income seems to play a role in the use of public transport. With higher income, respondents tended to demand lower fares less³⁵ and increasingly state that they will not use public transport³⁶. As car ownership correlates with income, higher income groups are not as dependent on public transport as those with lower incomes (Figure 25 and Figure 26).



Figure 26: Age and drivers for usage of public transport

N = 1000, multiple answers allowed

Source: Fraunhofer ISI

³³ r = 0.201 ³⁴ r = 0.218

 35 r = -0.158

³⁶ r = 0.094 **

5 Discussion and Conclusion

Overall, our findings corroborate prior Covid-19 survey studies and show that some early trends toward more sustainable behavior in the area of nonessential material consumption can be recognized. The pandemic had noticeable effects on self-reported consumption patterns across all four analyzed countries, with between a quarter and more than half of respondents reporting changes in their purchasing habits across all material goods categories. While in all four countries respondents reported an increase in purchases of online entertainment services, for the other consumption categories respondents reported fewer purchases, especially in the clothing and accessories category. Significantly, most of the people who purchased fewer material goods reported that they did not miss the items they had purchased regularly before the onset of the pandemic. Sustainability has increased in importance for many consumers. Both higher income and higher age increase respondents' likelihood of exhibiting sustainability-oriented purchasing behavior, whereas gender plays little of a role, except for the category of clothing.

While the area of mobility likewise saw significant pandemic-related changes both concerning trip frequency and purpose and transport modes, respondents' future intentions do not suggest significant gains in sustainability in this area. At the time of the survey, leisure trips and tourism showed the strongest decrease in frequency, followed by job/education-related trips. In all countries except the USA, a higher share of people started walking more, and bicycle use also increased. Although the use of shared modes of transportation plummeted, the use of private vehicles decreased as well. Concerning post-Covid-19 changes, however, an increase in mobility is likely for some trip purposes. Most respondents who predict a change in their mobility behavior want to travel more, especially for long-distance leisure trips. Respondents in some countries expected to walk and cycle more after the pandemic. These positive sustainability changes might still be offset by the relatively high percentages of respondents in all countries who expected to use private vehicles and planes more often.

It is noteworthy, that there is a certain tendency towards a continuity of pandemic-induced changes in mobility behavior. This applies to walking, cycling, private vehicle use, and public transport. The influence of gender on changes in mobility behavior underlines the classic role model still predominant in many families, as women reported a stronger reduction of shopping trips and errands and a weaker reduction of business and official trips. Contrary to this, however, women also plan to increase their mobility more than men after the pandemic, especially for leisure, vacation and work trips, but not for shopping and errands.

Altogether, the pandemic's influence on living conditions and mobility patterns affects younger people and those with low income more than older and higher income groups. The only exception is that the tendency toward teleworking and online meetings is stronger with higher income. Also the willingness to increase cycling and the use of public transport is more likely to be found among the younger ones.

In future work, we plan to perform further statistical analyses on this dataset, including crosscountry regression analyses. The objective will be to deepen our understanding of similarities and differences in the behavioral changes that took place in different countries and which factors most strongly motivated or hindered these changes. As the pandemic moves into its third year, it would be valuable to repeat the survey – ideally with the possibility of repeating it a third time post-pandemic. By doing so, we can create a longitudinal dataset and find out whether the Covid-19-crisis will, in fact, have long-term impacts on the transition toward sustainability or will, instead, create rebound effects after the end of the pandemic.

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A Survey Questions

A.1 Demographics

- 1) What gender do you identify as?
- ▶ male
- ▶ female
- diverse
- prefer not to answer
- 2) Age: ____ years
- 3) What is your monthly net household income?
- ► less than 1.000€
- ▶ 1.000 2.000 €
- ▶ 2.000 3.000 €
- ▶ 3.000 4.000 €
- ▶ 4.000 5.000 €
- ▶ more than 5.000 €
- prefer not to answer
- 4) What is the highest degree or level of education you have completed?
- no degree
- secondary school (Hauptschule)
- secondary school (Realschule)
- high school diploma (Abitur)
- Bachelor's degree
- Diploma or Master's degree
- PhD or higher
- prefer not to answer
- 5a) How many people, including yourself, live in your household? ____ persons
- 5b) How many of them are children between 6 and 18? ____ persons
- 5c) How many of them are children under 6? ____ persons

- 6) Which of the following categories best describes your employment status?
- employed (full-time)
- employed (part-time)
- self-employed/freelance
- looking for a job
- neither employed nor looking for work
- retired
- disabled or unable to work
- 7) Did your occupation or job status change as a result of the Covid-19 pandemic?
- no change
- ▶ I am working more hours than I did before
- ▶ I am temporarily working fewer hours than before
- ▶ I am working fewer hours than before and expect this change to be permanent
- I lost my job/had to close my own business
- Other
- 8) (For those who work): Since the COVID-19 pandemic, has there been a change in the location from which you work (home or outside the home)?
- no change
- I am now working exclusively from home
- I am now working partially from home and partially working outside the home
- Other
- 9) Has the financial situation of your household changed over the last 12 months? It has...
- Improved significantly
- improved slightly
- stayed the same
- gotten worse
- gotten significantly worse
- prefer not to answer

10) Have you or someone you care about tested positive for COVID-19?

- ▶ yes
- ▶ no
- prefer not to answer

A.2 Discretionary material consumption and related practices

 The following table is a <u>three-stage question</u> and lists different categories of discretionary material goods. Please indicate for each category whether you purchased goods from this category <u>regularly prior to the COVID-19 pandemic</u>; whether you have purchased <u>less, the</u> <u>same amount or more</u> of these goods <u>since the COVID-19 pandemic</u>; and finally <u>how much</u> <u>you plan to purchase after the end of the COVID-19 pandemic</u> as compared to before the pandemic.

	Before COVID- 19 pandemic	During COV	/ID-19 pande	mic	After the end of the COVID-19 pandemic, as compared to before the pandemic			
	Purchased regularly before COVID- 19	Purchase d less	Purchase d the same amount	Purchase d more	Plan to purchase less	Plan to purchase the same amount	Plan to purchase more	
Clothing & accessories								
Electronic devices (smartphone /tablet/com puter, TV, video game console, etc.)								
Books, DVDs, CDs								
Children's toys								
Online entertainme nt services (i.e. Netflix, Spotify, etc.)								

- 2) Do you miss the items you have purchased less since the start of the COVID-19 pandemic?
- Very much
- Somewhat
- No
- 3) With regard to the discretionary material goods you purchase, have you made any of the following changes to your habits since the start of the COVID-19 pandemic? Please select one answer per row.

	Did not make this change	Tried this change but stopped	Tried this change and continue today	Plan to make this change in the future	Was already doing this
l purchase more organic clothing.					
I purchase more fair trade clothing.					
I make my own clothing.					
I purchase more locally/regional ly produced goods.					
I make more purchases from local stores.					

- 4) For those who checked "tried this change but stopped", what was a barrier to continuing? Please check all that apply.
- Couldn't find such a product locally.
- Couldn't find such a product online.
- Finding/purchasing such a product required too much labor, energy, or time.
- ► New goods were too expensive
- New goods did not meet my expectations regarding function.
- ▶ New goods did not meet my expectations regarding looks/style/appearance.
- Other: _____

- 5) For those who checked "**did not make this change**", what prevented you from doing so? Please check all that apply.
- Couldn't find such a product locally.
- Couldn't find such a product online.
- Finding/purchasing such a product required too much labor, energy, or time.
- New goods were too expensive
- ▶ New goods did not meet my expectations regarding function.
- ▶ New goods did not meet my expectations regarding looks/style/appearance.
- Just not interested or don't need such a product
- Other: _____
- 6) For those who checked "**tried this change and continue today**", what do you feel enabled you to continue? Please check all that apply.
- Was able to buy the product locally.
- Was able to buy the product online.
- Extra availability of labor, energy, or time due to Covid-19
- Better value for my money
- ▶ New goods are superior in terms of their function.
- ▶ New goods are superior in terms of looks/style/appearance
- ▶ Conforms well with my personal values.
- ► Have been continuing out of necessity
- Other:_____
- 7) For those who checked "**plan to make this change in the future**", what leads you to want to make this change? Please check all that apply.
- ▶ Knowledge that the product is locally available
- Knowledge that the product is available online.
- I anticipate that there will be extra availability of labor, energy, or time due to Covid-19
- ▶ I feel that the products will offer better value for my money
- Knowledge that the new goods are superior in terms of their function.
- ▶ Knowledge that the new goods are superior in terms of looks/style/appearance
- Making the change conforms well with my personal values.

8) Have any of your possessions broken since the COVID-19 pandemic and how did you respond? Please check one answer per row.

	Did not break	I repaired the item myself, which I would ALSO have done before the COVID-19 pandemic	l repaired the item myself, which l would NOT have done before COVID-19 pandemic	I did not repair the item myself, but had it repaired (profession ally/in a repair shop)	l replaced the item	I neither repaired nor replaced the item; threw out the item
Clothing & accessories						
Electronic devices (smartphone/tabl et/computer, TV, video game console, etc.)						
Kitchen appliances						
Household (non- kitchen) appliances						
Children's toys						

- 9) For those whose **item was not repaired (by them or professionally)**, what were the barriers to repairing/having the item repaired? Please check all that apply.
- Do not know how to repair the item by myself.
- Am not interested in learning how to repair the item by myself.
- Do not have the necessary tools to repair the item myself.
- Do not have the necessary space to repair the item myself.
- Could not get the necessary replacement parts to repair the item myself.
- Professional repair is not available.
- Professional repair is too expensive.
- The item was not worth repairing.
- ▶ I preferred to purchase a new item with new/better functions.
- Other (please specify)

- 10) For those who **repaired the item and would not have done so prior to Covid-19**, what do you feel motivated and/or enabled you to perform the repair yourself? Please check all that apply.
- Extra availability of labor, energy, or time due to Covid-19
- Cheaper than professional repair
- Cheaper than replacing the item with a new one
- Better for the environment
- ► I enjoyed the activity of repairing
- ▶ Had or was able to acquire the necessary skills or knowledge necessary for the repair
- ▶ Had or was able to access proper equipment (tools) or space
- Professional repair was not available
- Professional repair is too expensive.
- Other (please specify)

A.3 Mobility

- 1) Do you own a car?
- yes / no
- 2) Which modes of transportation did you use at least once per week before the COVID-19 pandemic? (please check all that apply)
- Walking on foot
- Bicycle (including bicycle sharing services)
- Personal vehicle (car or motorcycle)
- Shared and unshared transport services (Taxi, Car sharing, ride sharing, etc.)
- ▶ Local public transportation (Bus, Tram, Subway)
- Long-distance public transportation (Train, Coach)
- Airplane

General changes in mobility since the COVID-19 pandemic

The COVID-19 pandemic abruptly changed the mobility behaviour of many people and caused many constraints. What about you?

3) How has the frequency of your trips with the following purposes changed since the COVID-19 pandemic?

	75 - 100 % less	50 - 75 % less	25 - 50 % less	0 - 25 % less	The same	0 - 25 % more	25 - 50 % more	50 - 75 % more	75 - 100 % more	Other chang es (speci fy)
Trips to work or education										
Business or official trips										
Shopping trips or errands										
Trips for leisure or entertainment (to the park, movie theater, etc.)										
Tourism, vacations or long-distance travels										

4) How has your use of the following transportation modes changed since the COVID-19 pandemic? (*as a share of the total trips you take*)

	75 - 100 % less	50 - 75 % less	25 - 50 % less	0 - 25 % less	The same	0 - 25 % more	25 - 50 % more	50 - 75 % more	75 - 100 % more	Other chang es (speci fy)
Walking on foot										
Bicycle										
Personal vehicle (car or motorcycle)										
Shared and unshared transport services (Taxi, Car sharing, ride sharing, etc.)										
Local public transportation (Bus, Tram, Subway)										

	75 - 100 % less	50 - 75 % less	25 - 50 % less	0 - 25 % less	The same	0 - 25 % more	25 - 50 % more	50 - 75 % more	75 - 100 % more	Other chang es (speci fy)
Long-distance public transportation (Train, Coach)										
Airplane										

5) Now imagine your personal future, after the end of the COVID-19 pandemic and all related constraints: To which extent will the frequency of your trips with the following purposes have changed <u>after</u> the end of the COVID-19-related constraints, <u>compared to the time</u> <u>before the COVID-19 pandemic</u>?

	75 - 100 % less	50 - 75 % less	25 - 50 % less	0 - 25 % less	The same	0 - 25 % more	25 - 50 % more	50 - 75 % more	75 - 100 % more	Other chang es (speci fy)
Trips to work or education										
Business or official trips										
Shopping trips or errands										
Trips for leisure or entertainment (to the park, movie theater, etc.)										
Tourism, vacations or long-distance travels										

6) To what extent will your use of the following transportation modes have changed <u>after</u> the end of the COVID-19-related constraints, <u>compared to the time before</u>?

	75 - 100 % less	50 - 75 % less	25 - 50 % less	0 - 25 % less	The same	0 - 25 % more	25 - 50 % more	50 - 75 % more	75 - 100 % more	Other chang es (speci fy)
Walking on foot										
Bicycle										
Personal vehicle (car or motorcycle)										
Shared and unshared transport services (Taxi, Car sharing, ride sharing, etc.)										
Local public transportation (Bus, Tram, Subway)										
Long-distance public transportation (Train, Coach)										
Airplane										

7) For those who changed their mobility habits: Why do you suppose that your mobility behaviour will be different after the end of COVID-19-related constraints than before?

(check all that apply)

- ▶ I will work and study from home more often.
- ▶ I will avoid business and official travels by doing video conferences.
- ▶ I will make fewer or shorter trips because I realized in the last months that this makes me happier.
- ▶ I will travel shorter distances because I have come to appreciate the recreation areas in my region / my country.
- ▶ I will make less trips, because I realized that some of them were not necessary.
- I will try to combine different errands in order to be more efficient and make less trips.
- I will do more trips because this makes me happy.
- Due to the COVID-19 pandemic my financial situation changed drastically

- ▶ Due to the COVID-19 pandemic my personal situation changed drastically
- Other: ______

Factors that promote mobility

8) Which measures would make you use public transport (at least) as frequently after the end of COVID-19-related constraints as before the COVID-19 pandemic?

(check all that apply)

- ▶ Hygiene measures in the vehicles (disinfection, face masks, air filters, etc.)
- More room and privacy in the trains and buses
- More frequent trains / buses
- Improved punctuality of trains and buses
- Lower fares
- Ability to bring my bicycle on public transportation more easily
- Better connection to bike sharing or e-scooter sharing
- Improved reachability / accessibility of key locations
- Other: _____
- ▶ The above measures would not influence my public transportation usage
- ▶ I did not use public transport before the COVID-19 pandemic nor will I after
- 9) Bicycle use has become more popular during the pandemic, because of the perceived safety from infection. Which measures would make you use a bicycle more frequently for everyday trips after the end of COVID-19-related constraints as before the COVID-19 pandemic?

(check all that apply, randomized order)

- More and more comfortable bike lanes
- Safe and protected bike lanes, that offer protection from cars
- Less car traffic
- More mutual consideration between all road users
- Financial and immaterial incentives (such as an additional day off, subsidies for e-bikes, etc.)
- Bicycle friendliness of my employer (bike parks, showers, etc.)
- Other: _____
- ▶ The above measures would not influence my bicycle usage
- ▶ I did not use a bicycle before the COVID-19 pandemic nor will I after