

INVESTIGATE THE ASSOCIATION OF THE AMOUNT OF KRAFT PAPER IN
MUNICIPAL WASTE WITH THE GROWTH OF E-COMMERCE

By

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Abstract:

This paper investigates the association of the amount of Kraft Paper in municipal waste with growth of the E-commerce industry.

Using New York city as a sample, three findings are presented – First, the aggregate waste per household decreased despite an increase in population over the years 2005, 2013 and 2017. Second, total U.S. Municipal paper and paperboard waste increased for several years but then started to decline and plateaued out in relation to E-commerce sales. Finally, the Kraft Paper in the waste had increased (~50%) with increasing sales in E-commerce of (~50%)

The design was presented stepwise with related Tables and Figures. Two associations were made, first between total U.S. Municipal paper and paperboard waste and E-commerce sales year over year from 2002-2017 (Fig 8), and second between Kraft Paper waste as a component of New York sample and E-commerce sales year on year from 2002 -2017 (Fig 9).

This positive association of Kraft Paper to E-commerce sales can serve as a diagnostic tool to highlight inefficiencies in packaging supply chains in the E-commerce sector which is growing rapidly. This study can be used in conjunction with other techniques to plan strategies to minimize generating and improve handling of waste. One such strategy for reducing waste and environmental impact would be the replacement of virgin pulp with recycled pulp.

Other studies may be necessary to validate findings of the positive trend between Kraft Paper and E-commerce sales. This is due to limitations in the availability of data involved in the WCS (waste characterization study) and the potential bias of New York city sample as a representative dataset for the U.S. population.

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DEDICATIONS

To my parents Neeta and Ajay Vale and brother Siddhartha Vale for their support and encouragement on this report.

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LIST OF ABBREVIATIONS

U.S.	United States of America
MSW	Municipal Solid Waste
WCS	Waste Characterization Study
PWCS	The Preliminary Waste Characterization Study conducted by New York City
SMRNY	Sims Municipal Recycling of New York
DSNY	New York City Department of Sanitation

CHAPTER 1.0 : INTRODUCTION

1.1 Background Information

Since the 1990's there was a boom in E-commerce business. Currently trends show that e-commerce has eclipsed traditional retail businesses. (Statista, eMarketer)

This in large part has already been seen in the growth of major e-commerce players such as Amazon, E-bay and Wayfair. In addition, many traditional brick-and-mortar retailers such as Best Buy, Walmart, Costco and Home Depot have moved aggressively into the e-commerce space.

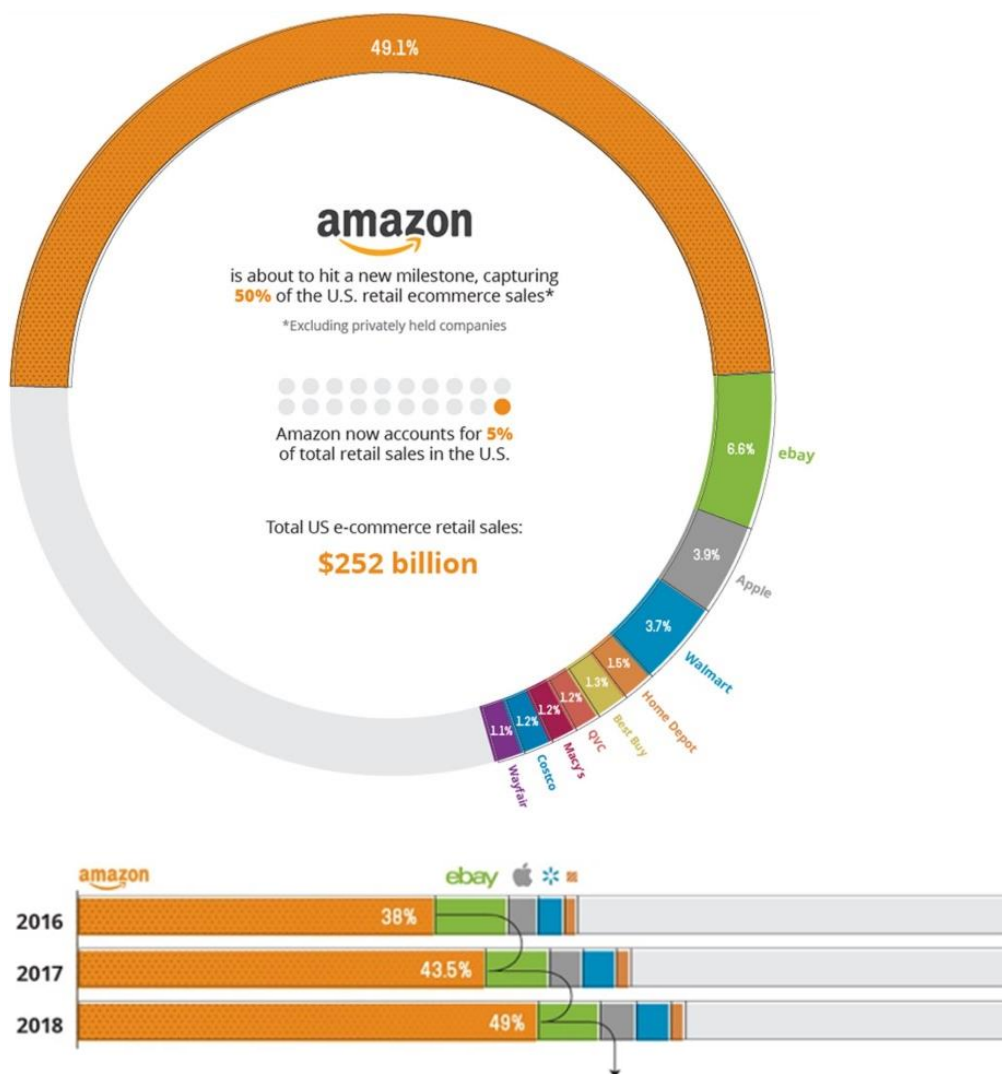


Fig 1a: The top 5 e-commerce companies by market share and sales in percentage

Source: emarketer, Statista, Amazon Press Release

The move to e-commerce has a major impact on components of packaging which is still dominated by containerboard which, in turn, uses Kraft as its building block (Kirwan, M

2013). As such, the study looks at associations of Kraft paper with certain other key variables such as population growth and household waste.

1.2 Statement of problem

To evaluate the increases of Kraft paper in municipal waste, for making an association with increasing sales of e-commerce companies (Kirwan, M. 2013).

The analysis is based primarily on publicly available information, including waste management data from Department of Sanitation New York (DSNY), population, and industry sales (Statista).

1.3 Aims/ Objectives :

The overall objective was to investigate association of the amount of Kraft Paper in municipal waste with the growth of E-commerce, using New York city as a sample.

To that end, the study considers three factors:

1. Investigating an increase in aggregate paper year on year in years 2005, 2013 and 2017 with an increase in population.
2. Investigating a 50% increase in the amount of U.S. Municipal Paper and Paperboard waste with a 50% increase of U.S. E-commerce sales year on year.
3. Investigating a 50% increase in the amount of Kraft Paper waste of the New York sample with a 50% increase of U.S. E-commerce sales year on year.

CHAPTER 2.0: METHODOLOGY

2.1 Research Strategies

All tables and figures were derived from Microsoft Excel. The figures were either directly taken from the source and mentioned in references or created using Microsoft Excel bar and charts, using data given in prior tables and/or figures.

The Design/Method provides details for this study.

2.2 Design/Method:

The methodology has been presented stepwise with related Tables and Figures. Despite the three key steps entailed in the abstract this step delves deeper in understanding the complete process. Thus, highlighting all the steps which led to association of Kraft Paper to U.S. E-commerce sales.

In the background information, Fig 1a provided an understanding of the extent of Amazon's dominance in the e-commerce infrastructure and was critical to grasp the scope of waste being generated.

The **first step** was important to test the validity of New York citywide sample dataset. For this Table 1, which was a list of 20 most populated cities in the United States was taken for the years 2010-2018. This generated Fig 1b, the population of U.S. by the 20 most populous cities in 2010 and 2018. The validity of the New York city sample is elaborated in the results section. The source used was the United States Census Bureau open source data.

The **second step** involves Table 2, which elaborated the type of waste generated using New York citywide sample for municipal waste collected in 2005, 2013 and 2017. Fig 2 which was derived from Table 2 was used to observe the aggregate paper waste. The **third step** involved Table 3 which was created to derive the amount of total paper generated in tons in the New York sample for municipal waste over three years – 2005, 2013 and 2017. This information was collated from Fig 3a, Fig 3b and Fig 3c. The **fourth step** involved Table 4 which was the New York citywide dataset for different types of paper waste for the years 2005, 2013 and 2017.

Since Kraft paper is one of the leading if not the most important components in the packaging of e-commerce, it was essential to study its association to the increasing E-commerce sales (Kirwan, M). Due to this, the **fifth step** involved getting Kraft paper as a component of total waste for the same three years. This was highlighted in Table 5 and Fig 5 using information from Table 3 and Table 4.

To extrapolate New York sample data for paper waste to countrywide U.S paper waste the next two steps- six and seven were crucial. The **sixth step** involved getting data for the generation of different materials as waste in U.S. Municipal stream from 1960-2015. This step involved using Table 6 to give Fig 6a. The total U.S paper generation seen in Fig 6b was then formed from Fig 6a.

To observe the increase in e-commerce, **step seven** involved getting a snapshot of the increase in e-commerce sales for the years 2002-2017. This involved Table 7 and Fig 7.

The last two steps dealt with association trends. **Step eight** involved using the information for paper as waste in the U.S. Municipal waste stream (Fig 6b) along with the snapshot for ecommerce sales for the years 2002-2017 (Fig 7). **Step nine and the last step** involved the association of OCC/ kraft paper in tons from the NY citywide sample dataset (Fig 5) with the snapshot for e-commerce sales for the years 2002-2017 (Fig 7).

Data Sources: The data was obtained from Department of Sanitation New York Open Data for the years 2005, 2013 and 2017.

CHAPTER 3.0: RESULTS AND DISCUSSION

3.1 Results:

Table 1: The List of 20 most populous cities in the United States of America by Population 2010 -2018.

Source: US Census Bureau, Population Division

City, State	2010	2011	2012	2013	2014	2015	2016	2017	2018
New York, NY	8,190,355	8,272,963	8,348,032	8,398,739	8,437,387	8,468,181	8,475,976	8,438,271	8,398,748
Los Angeles, CA	3,795,370	3,821,136	3,852,532	3,883,916	3,913,260	3,943,215	3,969,262	3,982,002	3,990,456
Chicago, IL	2,697,529	2,708,209	2,719,735	2,726,772	2,728,524	2,726,215	2,718,946	2,713,067	2,705,994
Houston, TX	2,098,446	2,124,143	2,160,086	2,198,280	2,240,982	2,286,630	2,309,752	2,317,445	2,325,502
Phoenix, AZ	1,449,295	1,470,052	1,499,839	1,527,336	1,556,552	1,584,927	1,613,581	1,634,984	1,660,272
Philadelphia, PA	1,528,293	1,540,322	1,551,797	1,558,371	1,565,604	1,571,258	1,576,390	1,580,221	1,584,138
San Antonio, TX	1,332,883	1,357,536	1,383,608	1,408,787	1,435,839	1,464,531	1,488,512	1,511,409	1,532,233
San Diego, CA	1,305,970	1,319,697	1,337,149	1,355,951	1,376,725	1,388,674	1,403,865	1,414,427	1,425,976
Dallas, TX	1,200,372	1,218,320	1,242,344	1,259,239	1,279,679	1,301,794	1,324,477	1,343,087	1,345,047
San Jose, CA	954,492	969,948	983,322	1,001,253	1,014,418	1,026,099	1,030,359	1,032,136	1,030,119
Austin, TX	806,423	828,694	854,841	875,463	901,734	921,545	939,768	951,750	964,254
Jacksonville, FL	823,123	829,554	836,997	842,762	852,560	865,835	880,495	891,736	903,889
Fort Worth, TX	748,481	764,034	781,059	796,175	815,135	835,950	856,902	875,456	895,008
Columbus, OH	790,935	800,522	812,711	827,824	841,740	855,012	866,918	881,763	892,533
San Francisco, CA	805,550	815,677	829,027	839,841	851,116	863,836	872,795	879,166	883,305
Charlotte, NC	738,534	754,840	773,336	792,183	807,589	825,733	842,937	859,347	872,498
Indianapolis, IN	821,555	827,604	835,379	844,081	849,634	853,238	857,488	861,890	867,125
Seattle, WA	610,639	623,050	636,495	654,224	670,925	688,156	710,510	729,601	744,955
Denver, CO	603,354	620,513	635,277	649,513	664,870	683,665	696,618	705,439	716,492
Washington, D.C	605,085	619,602	634,725	650,431	662,513	675,254	686,575	695,691	702,455

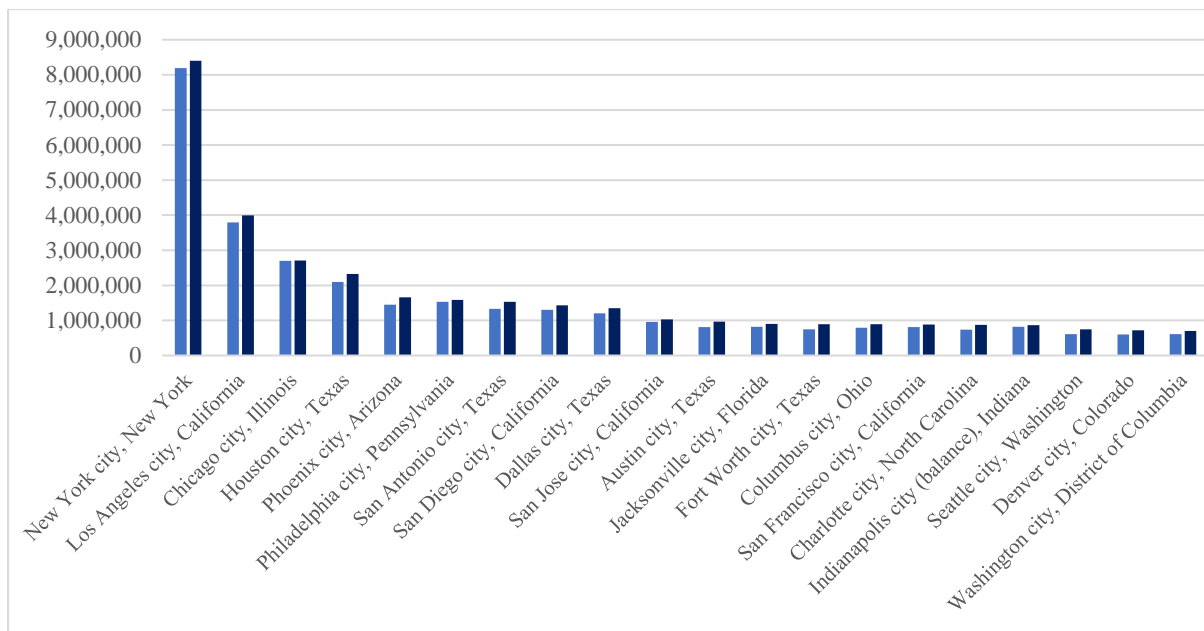


Fig 1b: Bar Graph of the populations in 20 most populous cities of the United States of America in 2010 and 2018.

The Fig 1b above showed that throughout 2010- 2018, New York was consistently the most populated city

Hence, as could be observed in Table 1 and Fig 1b above, New York is the most populated city of around 8 million throughout the five different boroughs. This population density and diversity gives it a unique advantage of representing the diversity of the U.S. population. Due to this, the study of a dataset of New York could be a valid representative sample of the population of the United States.

In the study, the New York citywide dataset is collected to point out differences in the composition of waste collected through 2005 -2017. Source: NYC Sanitation Open Data

Table 2: Type of waste New York Citywide in the years 2005, 2013, 2017

Material	2017 Aggregate	2017 Refuse	2017 MGP	2017 Paper	2013 Aggregate	2013 Refuse	2013 MGP	2013 Paper	2005 Aggregate	2005 Refuse	2005 MGP	2005 Paper
Paper	26.6%	21.0 %	6.8%	93.4 %	27.0%	21.3 %	6.9%	94.5 %	30.0%	23.3 %	5.2%	97.3 %
Plastic	14.9%	14.3 %	33.6 %	3.4%	14.0%	13.7 %	32.7 %	2.5%	14.2%	15.0 %	24.4 %	1.4%
Glass	4.5%	2.1%	29.9 %	0.6%	4.4%	2.0%	38.4 %	0.4%	4.5%	2.6%	32.9 %	0.1%
Metal	4.6%	3.2%	21.4 %	0.4%	3.5%	2.9%	15.5 %	0.3%	5.7%	4.1%	32.5 %	0.1%
Organics	43.3%	52.3 %	5.6%	1.7%	43.9%	51.8 %	3.9%	1.8%	38.9%	47.0 %	2.7%	0.9%
E-Waste	0.3%	0.3%	0.7%	0.1%	0.9%	1.0%	0.7%	0.1%	0.6%	0.7%	0.9%	0.0%
Constructi on & Demolition	4.5%	5.4%	0.5%	0.1%	5.1%	6.0%	0.3%	0.2%	5.2%	6.3%	0.4%	0.1%
Harmful Household Products	0.4%	0.5%	0.5%	0.1%	0.4%	0.4%	0.6%	0.1%	0.2%	0.3%	0.3%	0.0%
Miscellane ous Inorganics	0.8%	0.8%	1.1%	0.1%	0.8%	0.9%	0.9%	0.1%	0.6%	0.7%	0.6%	0.0%
Grand Total	100.0%	100.0 %	100.0 %	100.0 %	100.0%	100.0 %	100.0 %	100.0 %	100.0%	100.0 %	100.0 %	100.0 %

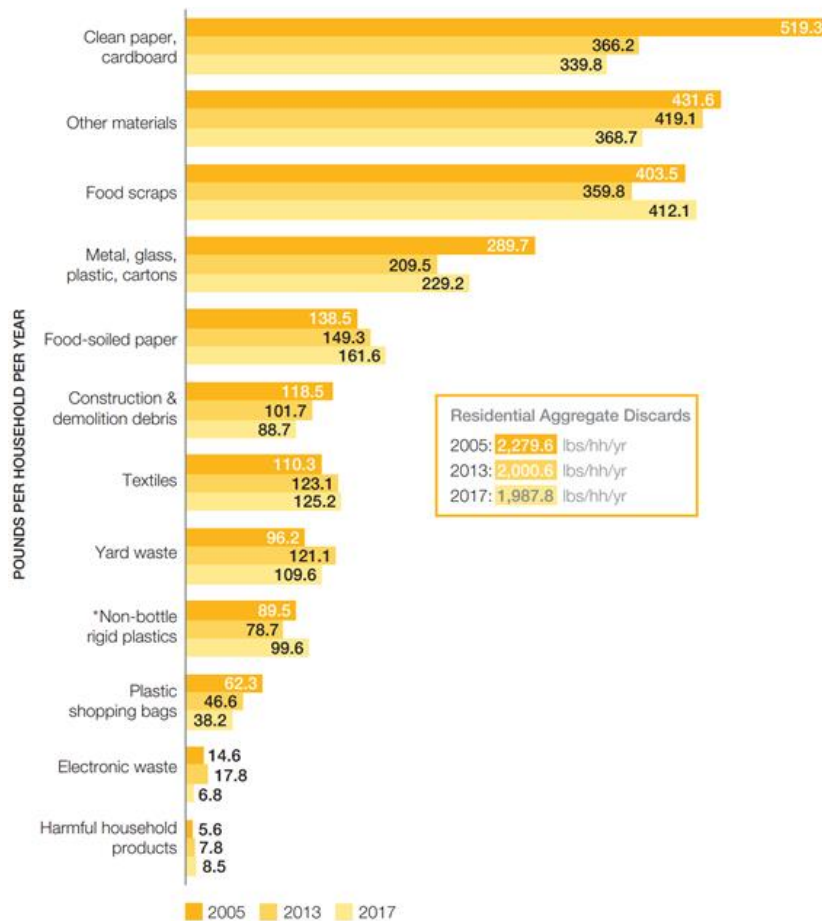


Fig 2: Composition of aggregate waste in pounds per household in New York sample over years 2005, 2013 and 2017.

An observation could be made that both Table 2 and Fig 2 showed a decrease in paper and cardboard in the aggregate collection from 2005-2017. Table 2 showed a decreasing percent of aggregate paper, while Fig 2 showed a decrease in aggregate paper per household.

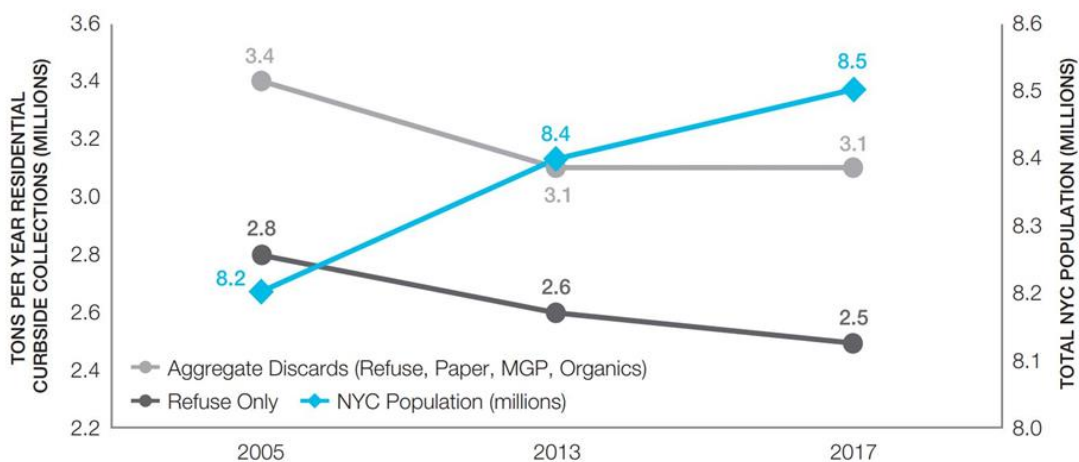


Fig 3a: The Aggregate and the Refuse only waste with changing population in 2005, 2013, 2017

As can be observed in the figure 3a above that the refuse only component decreased over the years despite the gradual rise in population. The data was got from DSNY.

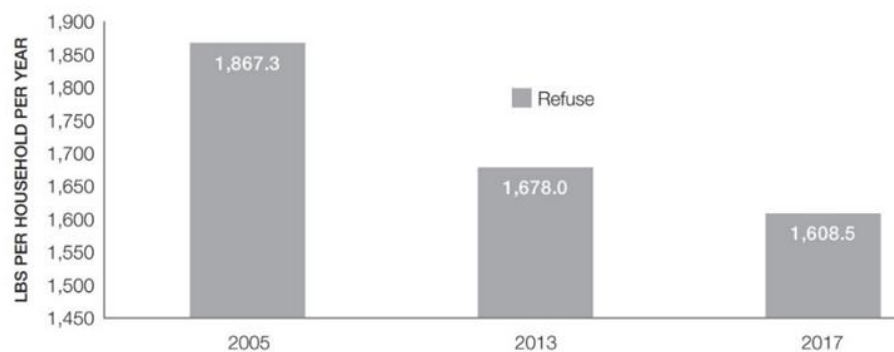


Fig 3b: NYC Residential Curbside Refuse Collections over Time, Per Household – Refuse Only (hh/year)

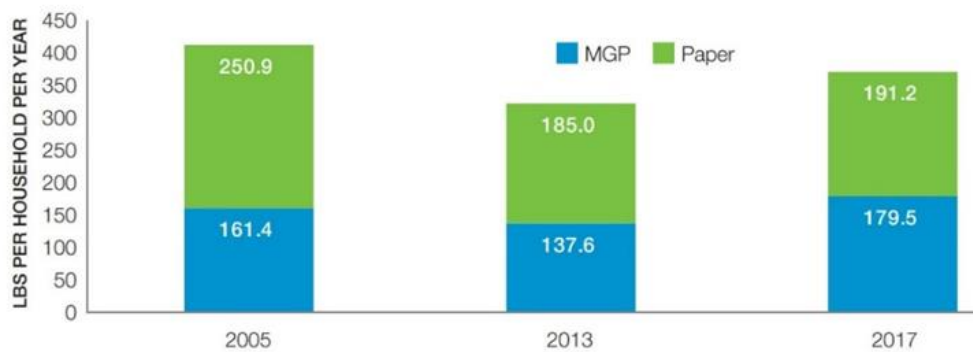


Fig 3c: NYC Residential Curbside Paper and MGP Collections over Time, Per Household – Paper (hh/year) and MGP (hh/year)

These measures show the amount of paper for the three years 2005, 2013 and 2017

With the information from Fig 3a, 3b and 3c, Table 3 could be generated, allowing the visualization of total paper waste in tons over the three years.

Table 3: Waste for total paper, MGP and Refuse in tons for the years 2005, 2013, 2017

Year	Paper (%)	Paper (lbs/hh/y)	MGP (lbs/hh/y)	Refuse (lbs/hh/y)	Total Refuse (tons)	Number of households = Total Refuse/(Refuse per household * 0.000454 lbs to tons)	Total Paper (tons)	Total MGP (tons)
2005	97.3	250.9	161.4	1867.3	2,800,000.00	3302844.15	376,222.35	242,017.89
2013	94.5	185	137.6	1678	2,600,000.00	3412915.522	286,650.77	213,206.20
2017	93.4	191.2	179.5	1608	2,500,000.00	3424507.419	297,263.68	279,073.38

Information from Fig 3a, 3b and 3c provides the Refuse and Total Refuse readings for 2005, 2013 and 2017. This in turn yields the number of households by the formulae given below,

$$\text{Number of households} = \text{Total Refuse} / (\text{Refuse (hh)} * 0.000454).$$

Once the number of households is achieved the Total Paper and Total MGP can be calculated for all three years 2005, 2013 and 2017. (Note: 0.000454 is a measure used to convert lbs into tons)

$$\text{Total Paper} = \text{Paper (lbs/hh/year)} * \text{Number of households for the year} * 0.000454$$

$$\text{Total MGP} = \text{MGP (lbs/hh/year)} * \text{Number of households for the year} * 0.000454$$

Table 4: Type of waste in sub-types of Paper as a component 2005, 2013, 2017 Comparison

Material	2017 Aggregate	2017 Refuse	2017 Paper	2013 Aggregate	2013 Refuse	2013 Paper	2005 Aggregate	2005 Refuse	2005 Paper
High Grade Paper	0.70%	0.50%	2.60%	1.30%	0.90%	5.90%	0.90%	0.70%	3.20%
Mixed Low Grade Paper	8.70%	6.80%	31.40%	9.30%	7.40%	31.90%	11.30%	8.80%	36.20%
Newspaper	1.90%	1.10%	9.80%	3.30%	1.50%	21.10%	7.50%	3.70%	41.60%
Other Nonrecyclable Paper	1.00%	1.10%	0.60%	0.90%	0.90%	0.90%	0.70%	0.70%	0.70%
Paper Beverage Cartons/Aseptic Boxes	0.40%	0.30%	0.30%	0.40%	0.30%	0.30%	0.50%	0.40%	0.30%
Paper: Compostable /Soiled/Waxed OCC/Kraft	8.10%	9.80%	1.40%	7.50%	8.80%	0.60%	6.10%	7.20%	1.40%
Plain OCC/Kraft Paper	5.70%	1.40%	47.20%	4.40%	1.50%	33.70%	3.10%	1.90%	14.00%

It was observed in Table 4 that despite the total composition of paper not changing much from 2013 to 2017, there was an increase in the percentage of plain occ/Kraft Paper which was the main tool for the building of containerboard. Thus, the total amount of Kraft Paper in tons in the years 2005, 2013 and 2017 could be obtained using total paper in Table 3 along with the percent Kraft Paper.

Table 5: Amount of total Kraft Paper in tones in 2005, 2013 and 2017

Year	Total Paper (tons)	Kraft Paper (%)	Total Kraft Paper (tons)
2005	376,222.35	14	52,671.13
2013	286,650.77	33.7	96,601.31
2017	297,263.68	47.2	140,308.46

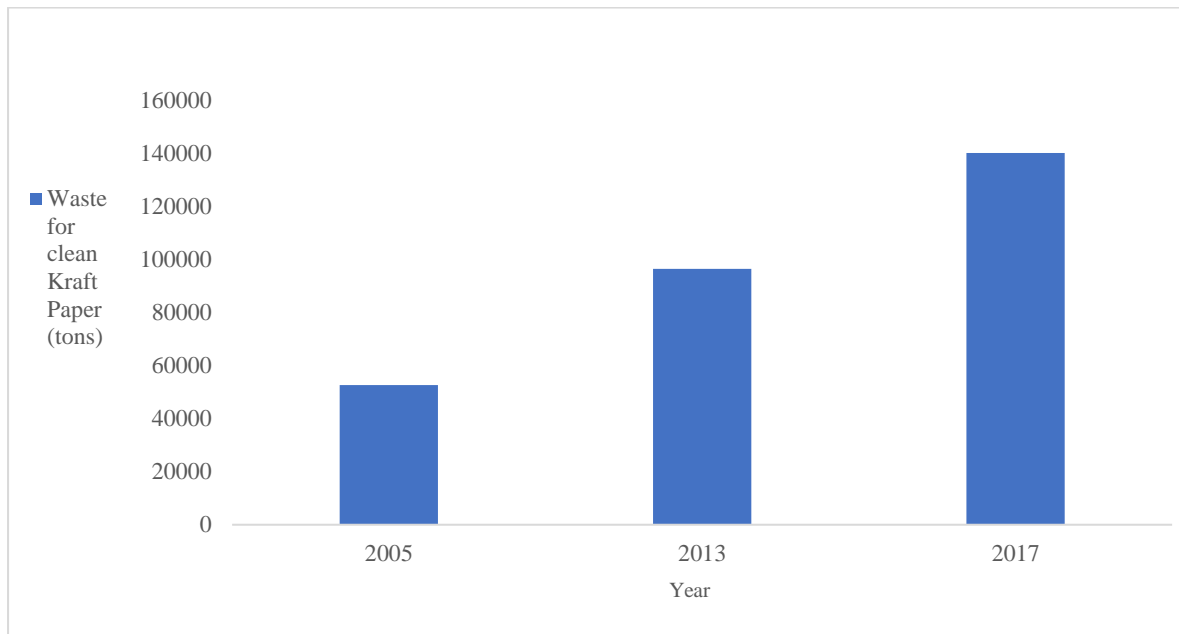


Fig 5: Amount of Kraft Paper in tonnes in 2005, 2013 and 2017

Since the year on year Kraft paper information was achieved it was important to consider the total US Municipal waste stream and paper as a component of that.

Table 6: Generation of selected materials in the U.S. Municipal Waste Stream between 1960 and 2015 (in 1000 tons).

Source: Statista

Year	Paper and Paperboard	Glass	Metals	Plastics	Rubber and Leather	Textiles	Wood	Other Material
1960	29900	6720	10820	390	1840	1760	3030	70
1970	44310	12740	13830	2900	2970	2040	3720	770
1980	55160	15130	15510	6830	4200	2530	7010	2520
1990	72730	13100	16550	17130	5790	5810	12210	3190
2000	87740	12770	18940	25530	6670	9480	13570	4000
2005	84840	12540	20400	29380	7290	11510	14790	4290
2010	71310	11520	22450	31400	7750	13220	15710	4710
2011	69950	11490	22080	31970	7600	13130	15780	4650
2012	68620	11590	22290	31940	7570	14340	15820	4580
2013	68600	11540	23060	32520	7720	15130	15770	4580
2014	68610	11480	23540	33390	8210	15240	16120	5120
2015	68050	11470	24000	34500	8480	16030	16300	5160

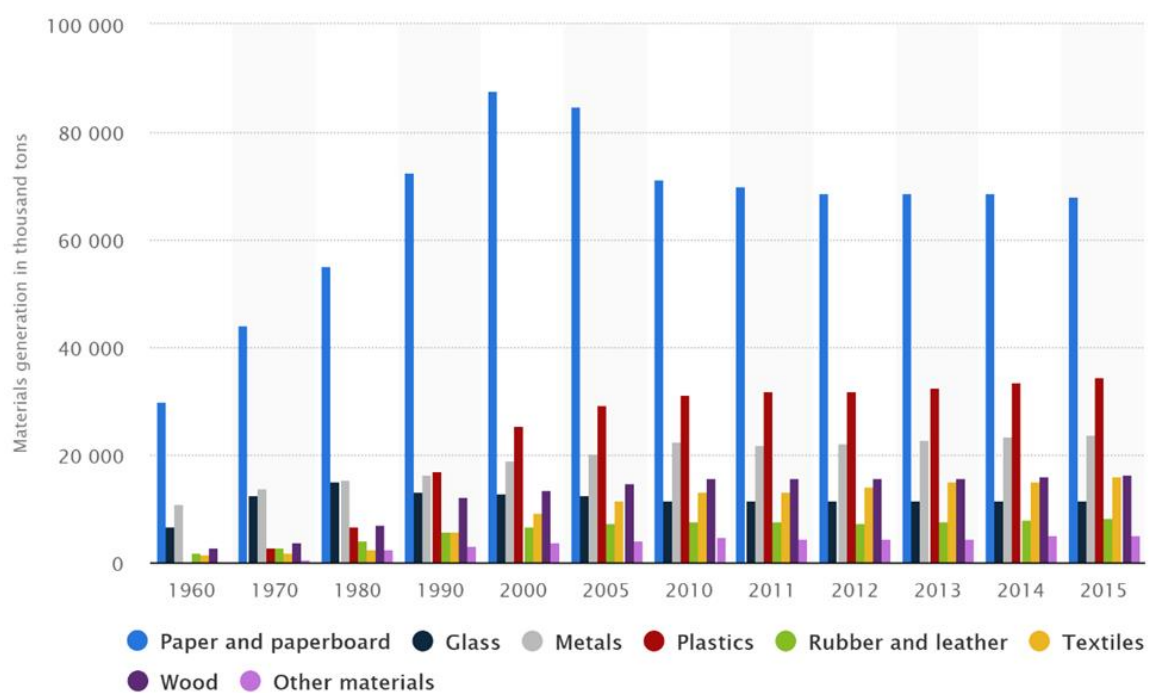


Fig 6a: Generation of selected materials in the U.S. Municipal Waste Stream from 1960 to 2015

Since the focus of this article is paper generated from U.S. Municipal Waste Stream. Fig 6b was created from information in Fig 6a taking only U.S. Municipal Paper and Paperboard over the given time period.

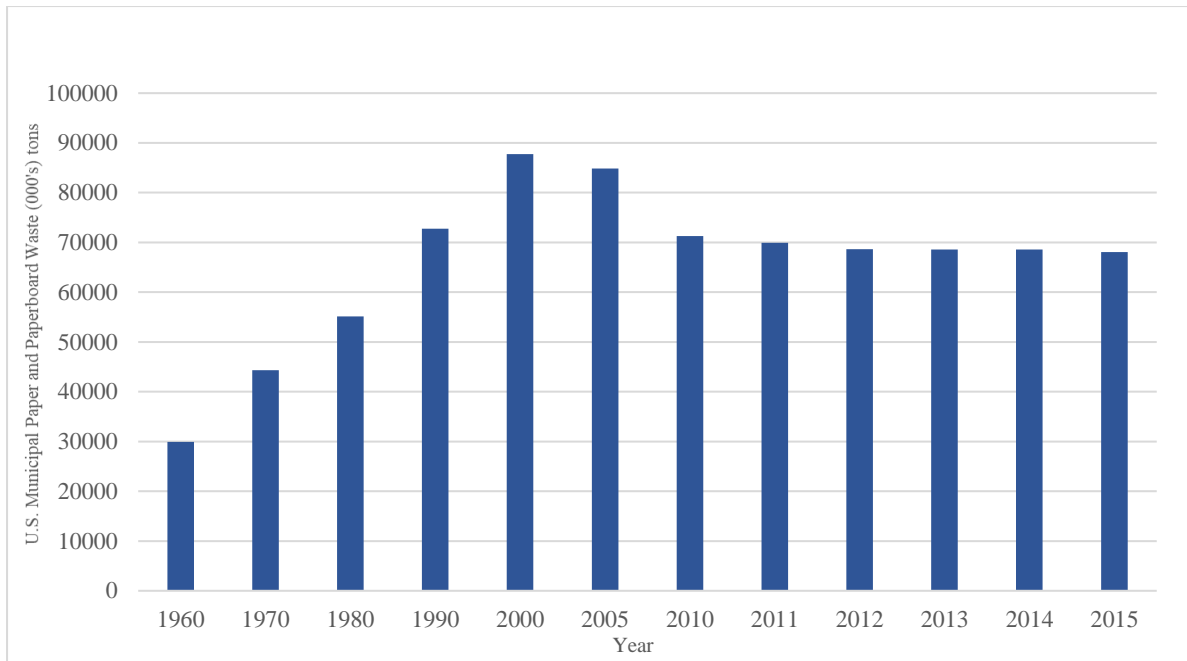


Fig 6b: U.S. Municipal Paper and Paperboard waste in million tons from 1960-2015

As can be seen in the Fig 6b above Paper and Paperboard continued to increase in the US Municipal waste stream from the 1960's through to the 2000. This could display the increased need for paper and paperboard from 1960-2000. However, the peak in 2000 and its subsequent fall from 2000-2005 could demonstrate a decreased demand during that period. From 2010 to 2015 there was not much change in the amount of paper and paperboard and annual generation tend to be ~ 68-70 million tones .

It was important to consider the increase in e-commerce component of retail sales in order to make an association between the paper and e-commerce sales. Hence information about the e-commerce sales was obtained in Table 7 and Fig 7 below.

Table 7: Desktop retail e-commerce sales in the US from 2002 to 2017 (in billion USD).

Source : Statista

Year	E-Commerce Sales (USD billions)
2002	42
2003	53
2004	67
2005	82
2006	102
2007	123
2008	130
2009	130
2010	142
2011	162
2012	186
2013	211
2014	237
2015	256.1
2016	291.8
2017	335.7

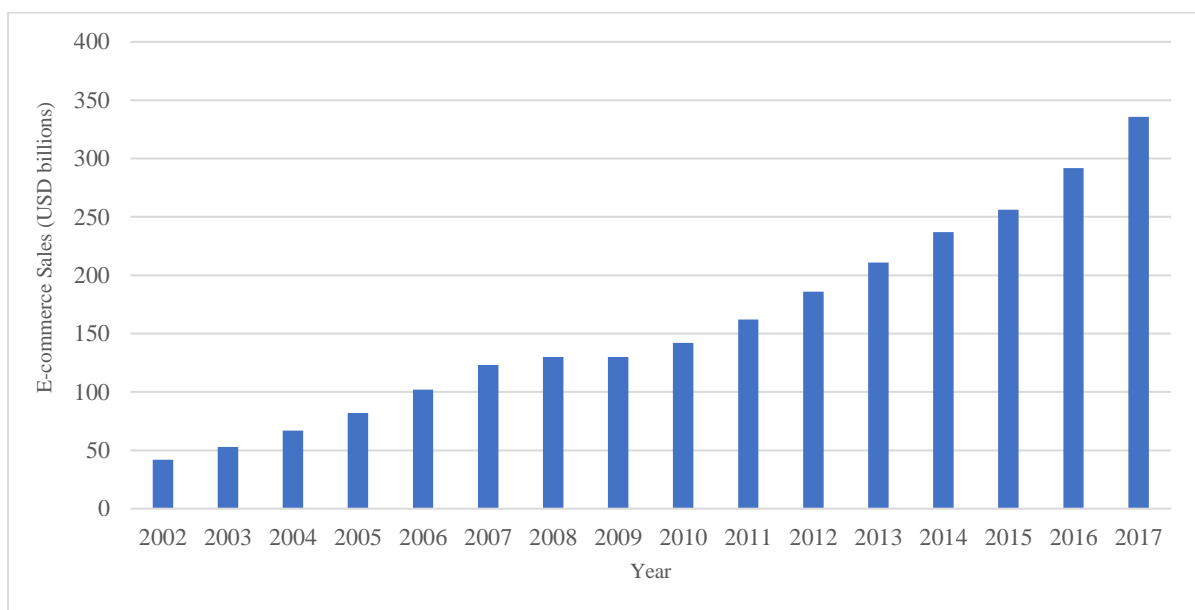


Fig 7: Desktop retail e-commerce sales in the U.S. from 2002 to 2017 (in billion U.S. dollars)

Source: Statista 2019

Since both the figures 6b and 7 have been obtained, a side by side comparison could be made to observe a trend and make an association chart between the two.

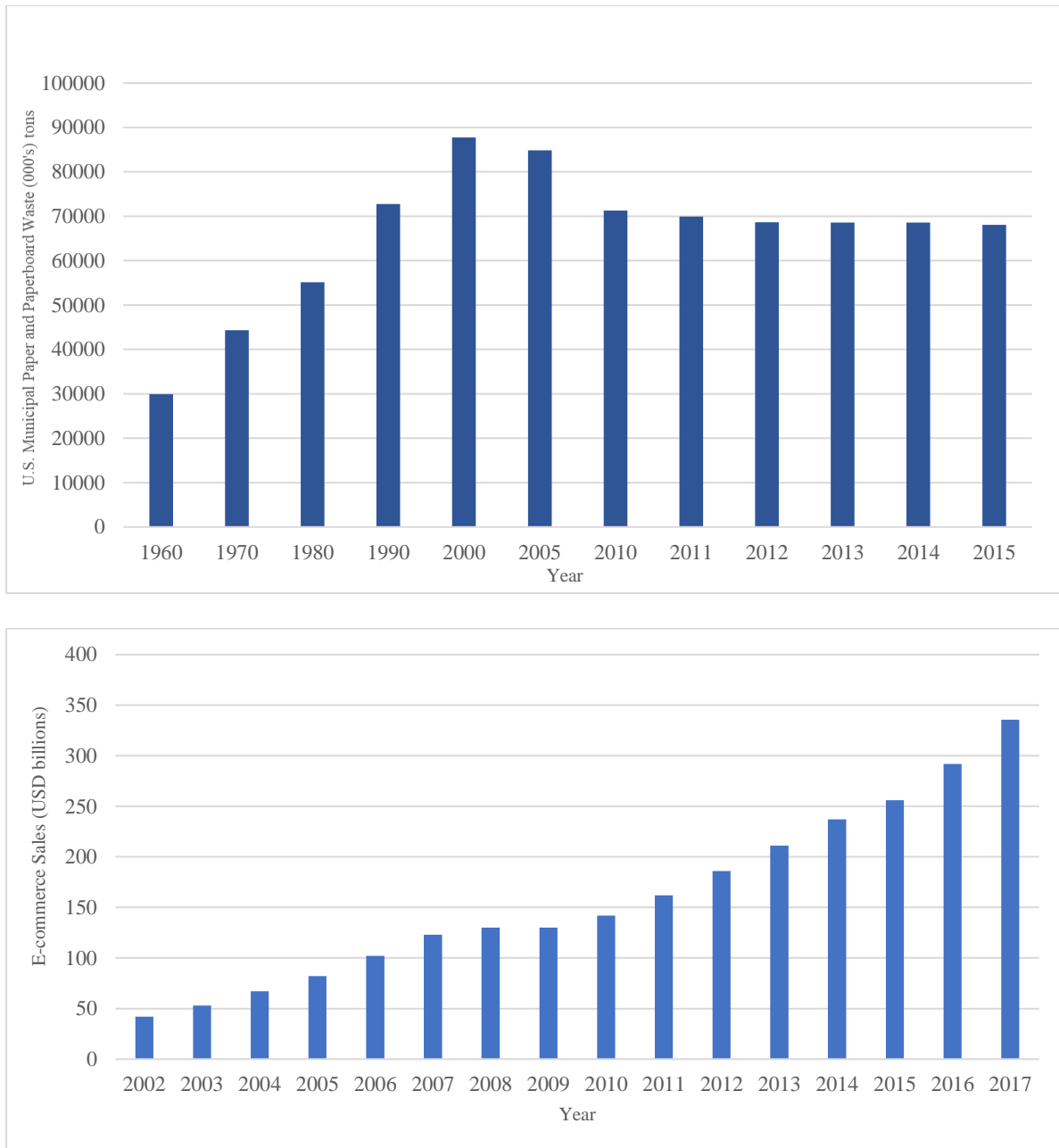


Fig 8: Comparing Paper waste generated from 1960- 2015 with Desktop retail e-commerce sales in US from 2002-2017

For mapping this out a side by side comparison for Paper waste (Fig 6b) to Desktop e-commerce (Fig 7), Fig 8 was created.

It could be observed in Fig 6b that from the years 1990-2000 there was an increase in the paper and paperboard generated. However, a peak was reached in the year 2000 followed by a dip and then a plateau. As opposed to this, Fig 7 showed a continual year on year increase in the retail e-commerce sales in the U.S. all the way from 2002-2017. Furthermore, the percentage decrease in Paper and Paperboard This indicates that there is no clear association

between the Paper and paperboard generated in the U.S. municipal waste stream (Fig 6b) to the gradual year on year rise in E-commerce sales.

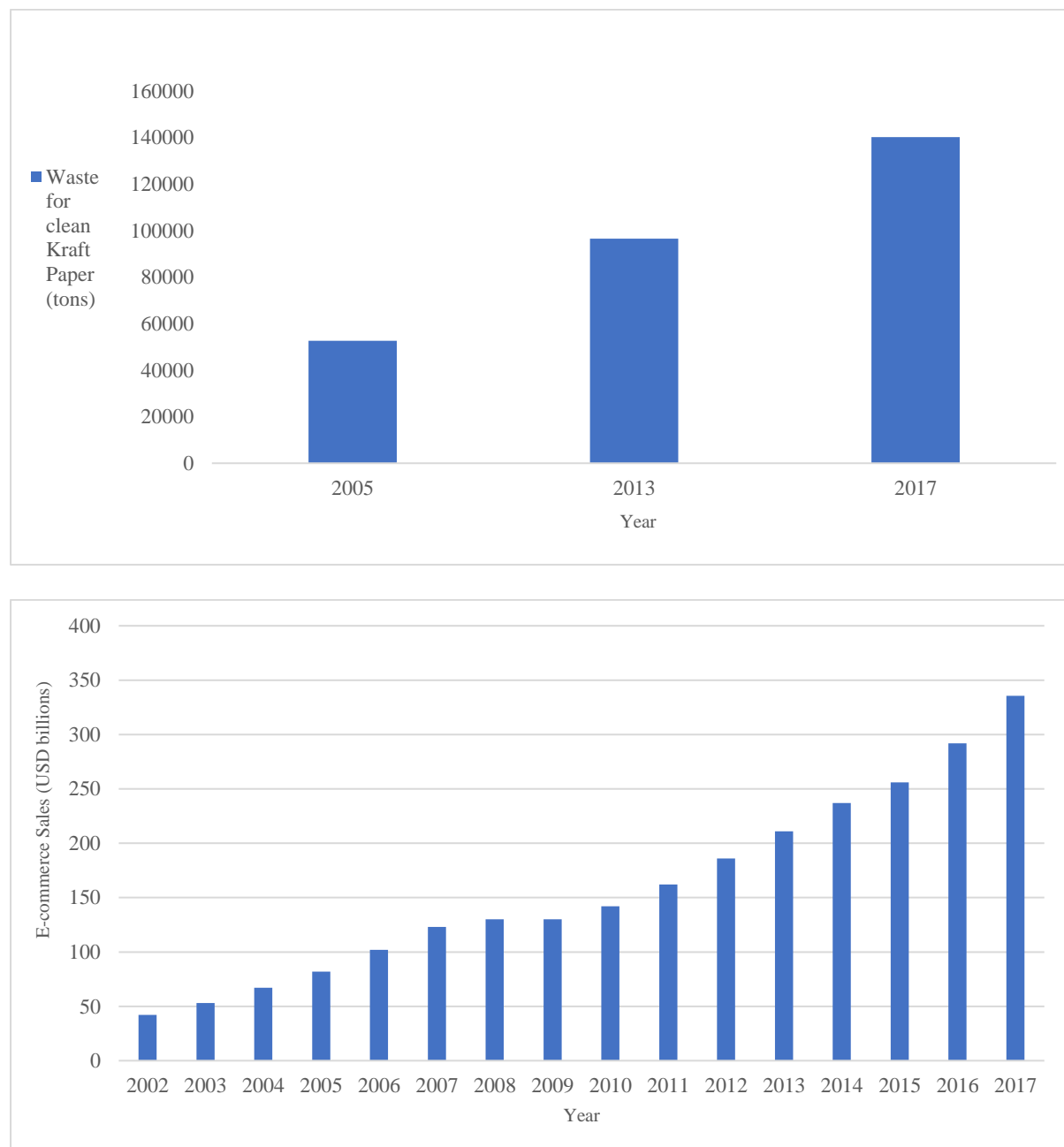


Fig 9: Comparing Kraft Paper generated 2005, 2013 and 2017 with Desktop retail e-commerce sales in US from 2002-2017.

Unlike the earlier comparison, Fig 9 showed a positive association. There was an increase in waste generation for clean Kraft paper from 2005-2017 (Fig 5) with an increase in Desktop retail e-commerce in the US from 2002-2017 (Fig 7).

In period from 2005-2013 the increase in E-commerce sales was 129 billion USD or a **157.3%** increase.

Amount increase = 211 billion USD (2013) – 82 billion USD (2005) = 129 billion USD.

Percentage increase = $(129 / 82) * 100 = \mathbf{157.3\%}$

While in the same period of 2005-2013 the increase in Kraft Paper waste in New York sample was 43930.18 thousand tons or a **83%** increase

Amount increase = 96601.31 thousand tons – 52671.13 thousand tons = 43930.18 thousand tons

Percentage increase = $(43930.18 / 52671.13) * 100 = \mathbf{83\%}$

In period from 2013-2017 the increase in E-commerce sales was 124 billion USD or a **58.7%** increase.

Amount increase = 335 billion USD (2013) – 211 billion USD (2005) = 124 billion USD.

Percentage increase = $(124 / 211) * 100 = \mathbf{58.7\%}$

While in the same period of 2013-2017 the increase in Kraft Paper waste in New York sample was 43930.18 thousand tons or a **45.3%** increase

Amount increase = 96601.31 thousand tons – 52671.13 thousand tons = 43930.18 thousand tons

Percentage increase = $(43707.15 / 96601.31) * 100 = \mathbf{45.3\%}$

3.2 Discussion

It could be demonstrated that there was a decrease in aggregate waste per household for paper and paperboard despite an increasing population seen in 2005, 2013 and 2017, as seen below.

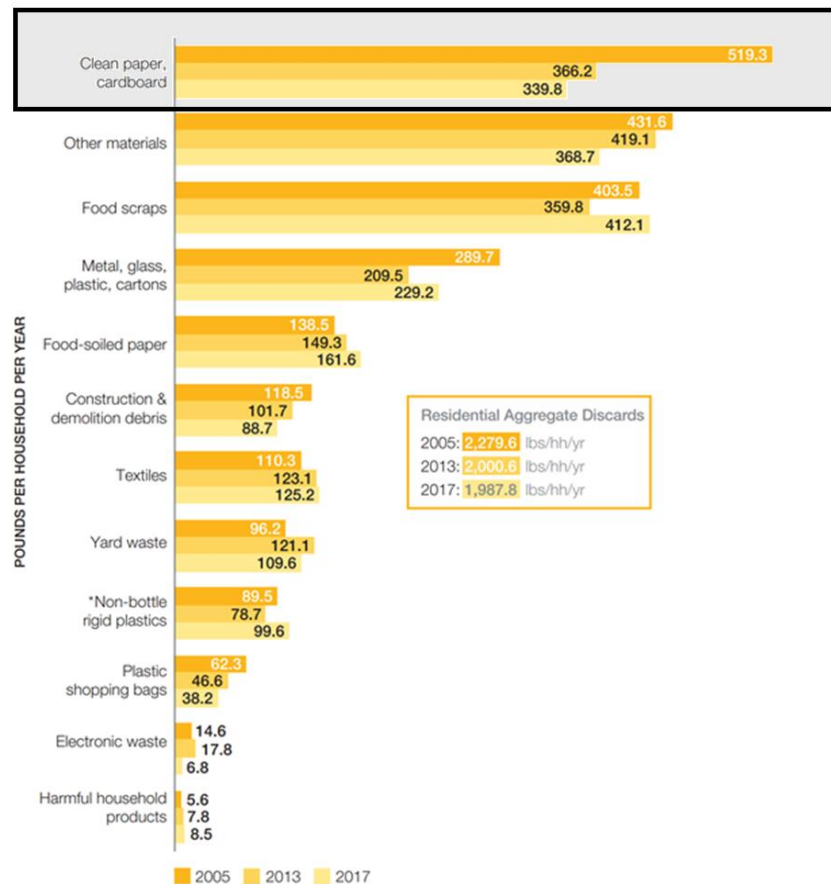


Fig 2: Composition of aggregate waste in pounds per household in New York sample over years 2005, 2013 and 2017.

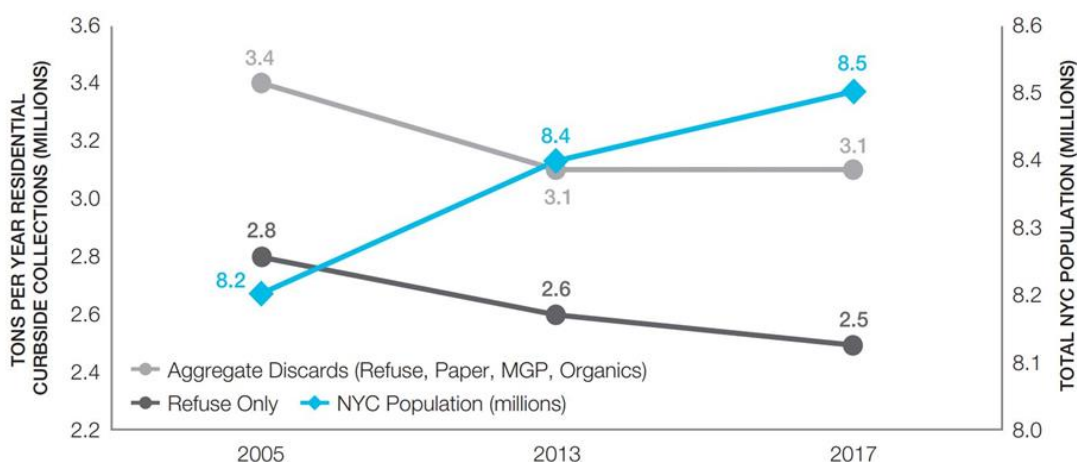


Fig 3a: The Aggregate and the Refuse only waste with changing population in 2005, 2013, 2017

This contradicted the expectation of the first aim which predicted an increase in paper aggregate waste over the three years. The cause of this decrease could be an increase in recycling attempts by New York aggregate waste collection along with efficiencies adopted in waste management in the collection of aggregate waste. This decrease could be seen in Fig 2 and Fig 3a. Fig 3a showed a decrease in aggregate waste despite an increase in population.

Moving the scope to the second aim, it could be seen in Fig 8 that an increase in the E-commerce sales year on year was not reflected in the U.S. Municipal Paper and paperboard waste as this graph peaked at around year 2000, dipped in the year 2005 and eventually plateaued.

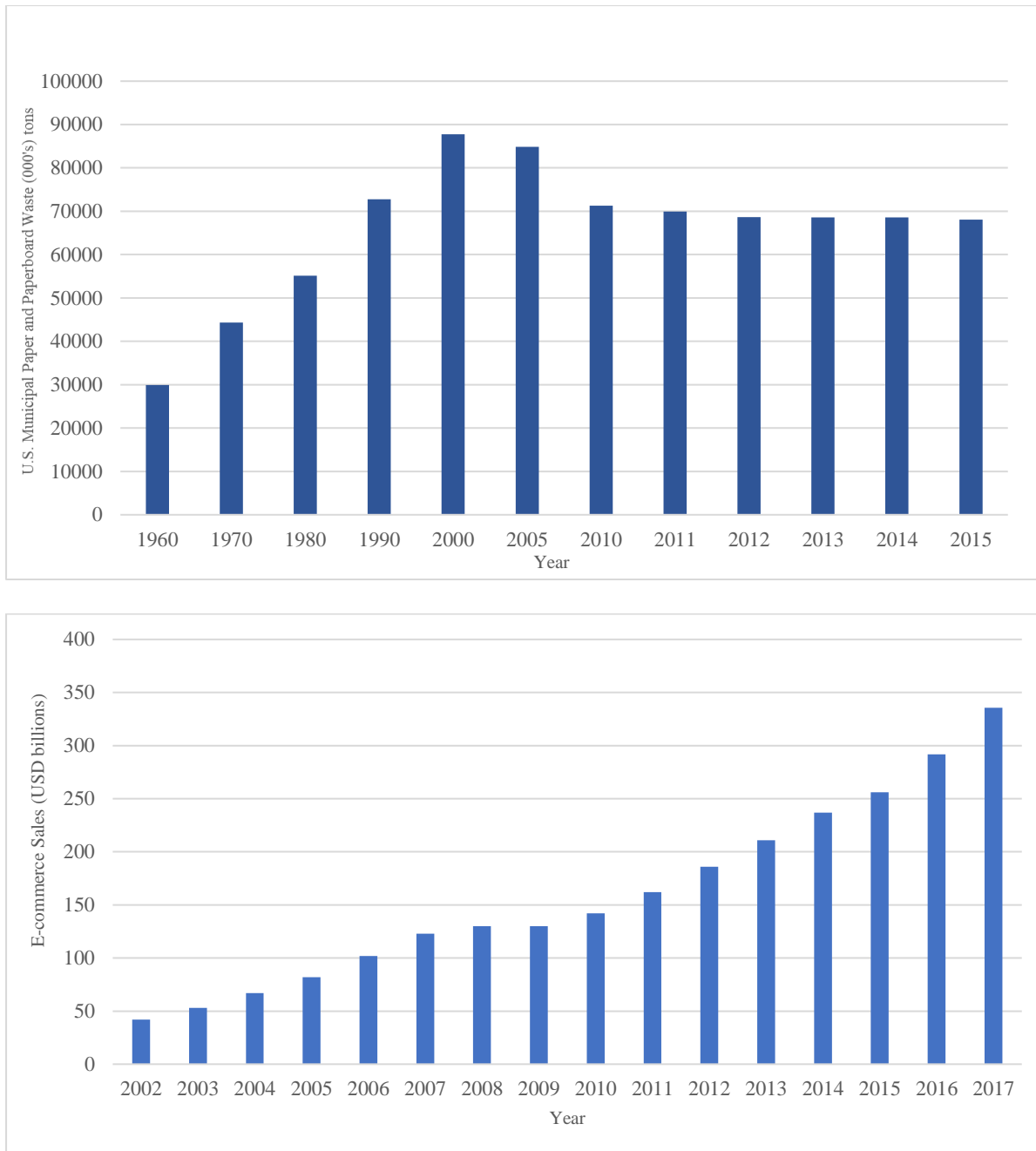


Fig 8: Comparing U.S Municipal Paper and Paperboard waste (million tons) from 1960- 2015 with Desktop retail e-commerce sales in US from 2002-2017

Hence this association displayed that the expectation of a 50% increase of U.S. Municipal Paper and paperboard waste did not correlate to a 50% increase of E-commerce sales

It was critical to demonstrate the increase in Kraft paper as a component of the total waste in the NY dataset with increasing desktop E-commerce sales (Fig 9).

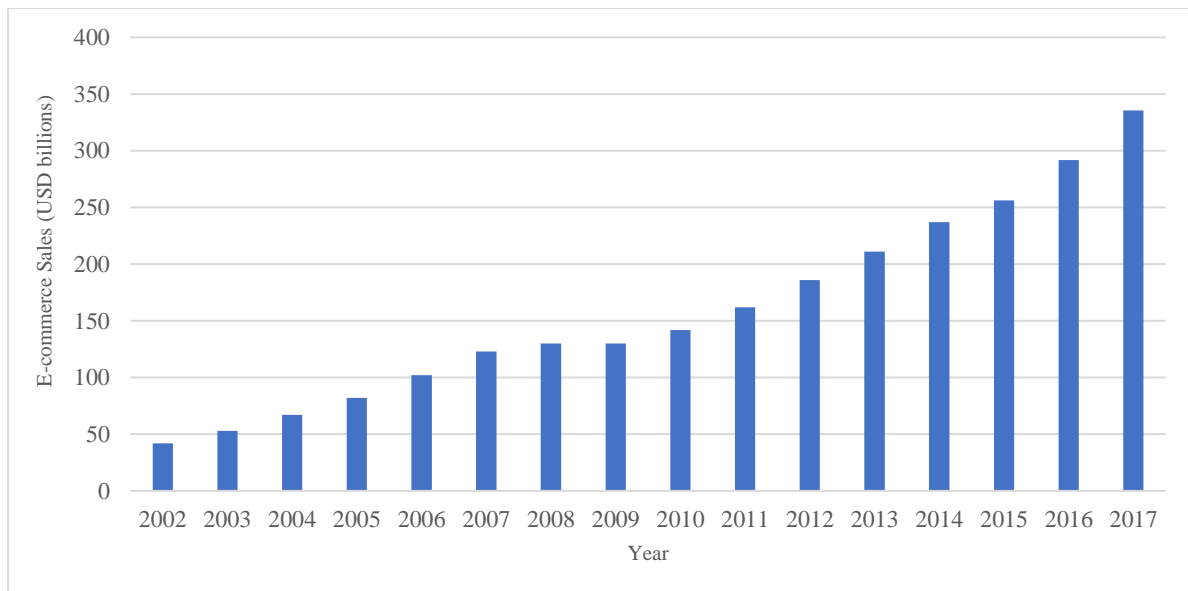
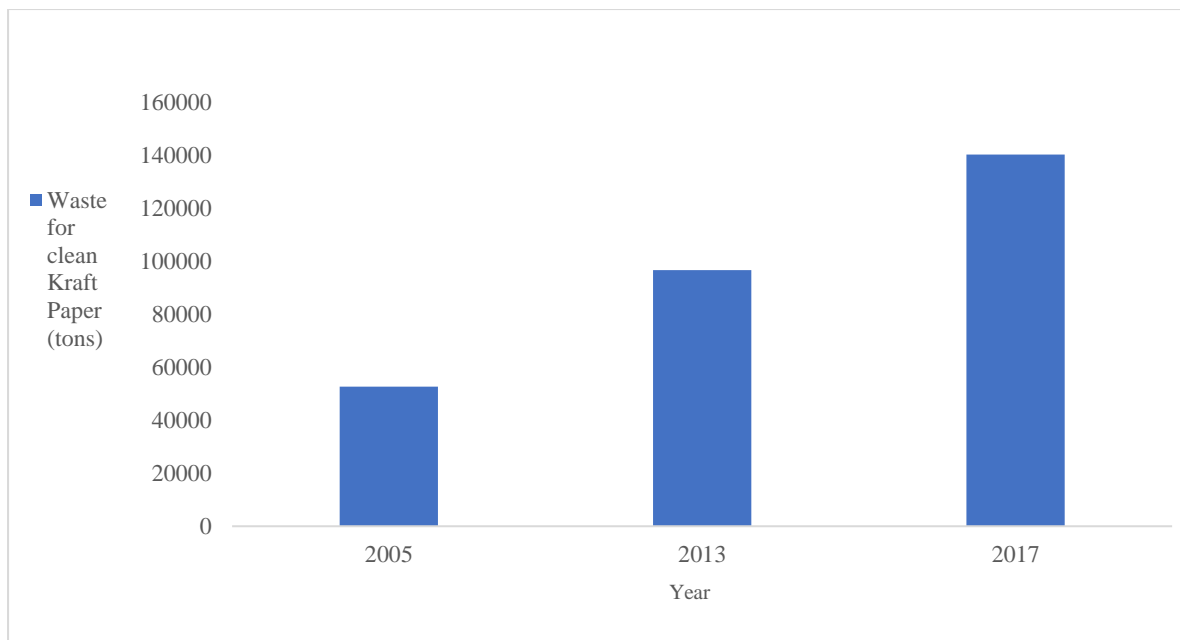


Fig 9: Comparing Kraft Paper generated 2005, 2013 and 2017 with Desktop retail e-commerce sales in US from 2002-2017.

Furthermore, in the results it could be observed that during the period of 2005-2013 there was an increase in E-commerce sales of 129 billion USD or 157.3 %, this corresponded with an increase in Kraft paper of 43930.18 tons or 83 %.

As compared to this, in the period of 2013-2017 there was an increase in E-commerce sales of 124 billion USD or 58.7%, this corresponded with an increase in Kraft paper of 43707.15 thousand tons or 45.3%.

Hence, E-commerce sales increase of 157.3% with Kraft paper increase of 83% in 2005-2013 and an E-commerce sales increase of 83% with Kraft paper increase of 45.3% in 2013-2017 point to the fact that there is almost a 1 to 1 correlation.

Due to this the association displays that the expectation of a ~50% increase of E-commerce sales could be correlated to a ~50% increase of Kraft Paper waste.

The increased presence of Kraft Paper in NY sample in 2005 -2017 (Fig 9) despite a decrease in U.S. Municipal Paper and Paperboard waste (Fig 8) could be due to reasons such as a decrease in the use of Print paper and Newspaper in 2002 as opposed to 1990. This fall also could be due to the rise of the internet and fall of the traditional methods of paper use such as newspaper and print. This trend is also highlighted in the global paper consumption from Fig 10 given below. (FAO Year Factbook Statistics).

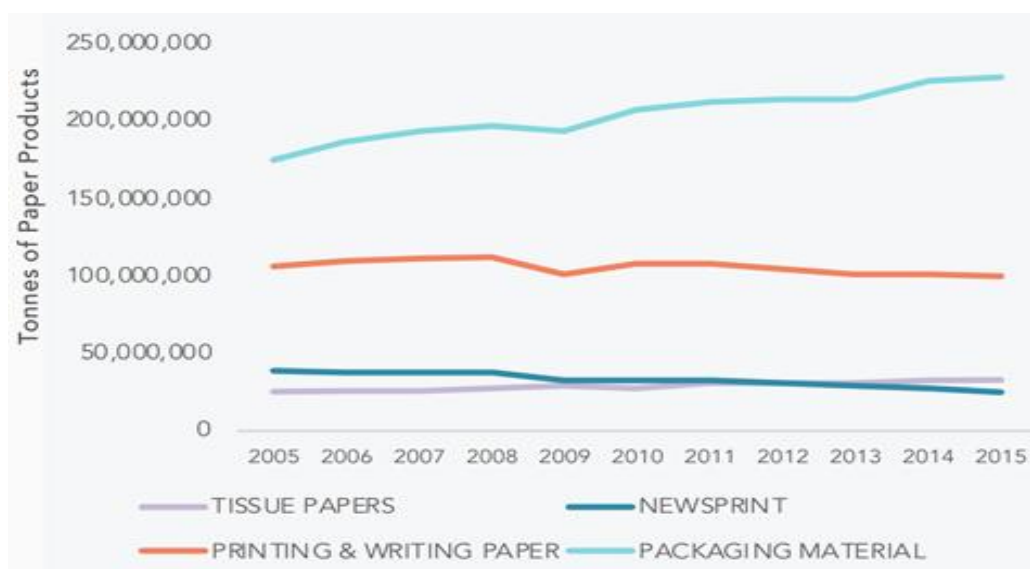
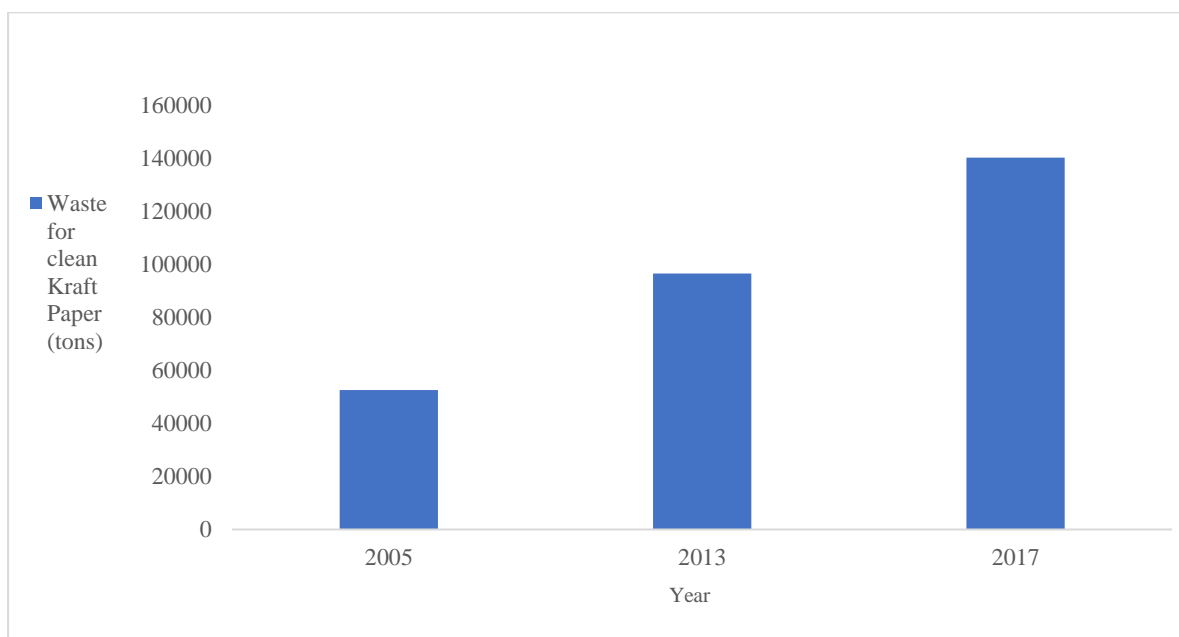
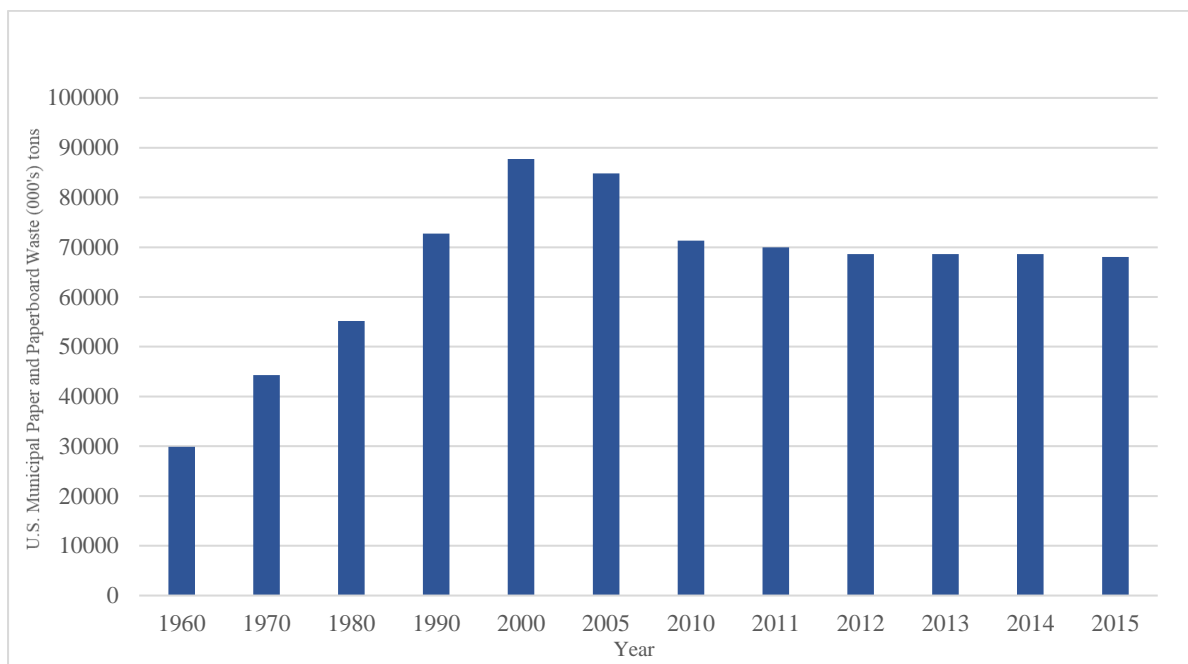


Fig 10: Global paper product consumption, 2005-2015, by selected product types

Source: FAO Year Factbook Statistic

As seen below, the total paper in US Municipal waste stream in the years 2005 and 2013 was 84.8 million tons and 64.6 million tons respectively, while the Kraft Paper component in the NY sample in the years 2005 and 2013 was 52700 tons and 96600 tons respectively. The two figures together showed that despite the decline in the paper generated in U.S. Municipal Waste Stream, the amount of Kraft paper waste as a component of E-commerce packaging has increased.

Due to unavailability of data for total paper in US Municipal waste stream for the year 2017, comparison with Kraft paper waste could not be made for that year.



As mentioned earlier, increase in Kraft paper showed that it was one of the leading components if not the most important component in the packaging of E-commerce companies by being a raw material in the production of paperboard or cardboard (Kirwan M).

This association of Kraft paper to E-commerce sales assists in the use of Kraft paper as a yardstick for amount of cardboard being used as a part of E-commerce sales. (Global Chelating Agents Market Report).

CHAPTER 4.0 : SUMMARY

Growth of e-commerce has a significant positive association with the use of Kraft Paper in packaging and despite population growth, has contributed to stabilizing overall waste per household.

The association can be used to reduce inefficiencies in supply chains, improve municipal handling of household waste, reduce packaging costs and adopt more environmentally friendly packaging options such as increased use of recycled pulp over virgin pulp in the manufacturing of Kraft Paper.

4.1 Limitations

Since the WCS is performed only for the years 2005, 2013 and 2017 for the NY sample dataset, it is difficult to use this data and findings more broadly. As such, further studies would be necessary to analyze effects of increasing Kraft paper presence in municipal waste collections.

Furthermore, certain limitations in making a link between Kraft paper in container board waste to e-commerce industries could be the presence of Kraft paper in the containerboard packaging of the food industry and to-go packaging, despite most of this being semi soiled paper and being distinguished from clean Kraft/OCC in the Table 4.

Another limitation is the fact that despite New York being a good representative sample it is after all a sample with a potential bias. It fails to highlight the difference in efficiencies it contained when compared to certain cities in the Midwest or rural regions which could not have benefited from such resource efficiencies over the years.

4.2 Conclusion

The article helps in understanding of many waste management issues: first, the aggregate paper and paperboard per household has decreased despite an increase in population. Second, the unclear trend of the association between U.S. Municipal Paper and paperboard waste and year on year E-commerce sales. Third and finally, the clear positive association between Kraft paper as the raw material for containerboard and E-commerce sales due to a ~50% increase in Kraft paper with a ~50% increase in E-commerce sales.

The third is crucial to understand that Kraft paper is the leading component for containerboard thus linked in E-commerce sales until substitutes are used.

This conclusion can point to the importance of Kraft and subsequently be used to explore areas of research which increase Kraft utilization efficiency and allow plans to minimize waste.

5.0 FUTURE TRENDS

5.1 Future Applications

Since paper and paperboard waste are a component of municipal solid waste it was crucial to observe the snapshot of this globally. Data collected from 1990-2017 demonstrated that the amount of municipal solid waste collected had been rising year on year. The prediction, that by the year 2050 the world is expected to generate 3.4 billion tons of waste annually from today's 2.01 billion tons annually could be observed in Fig 11a. (Kaza, 2018).



Fig 11a: Projected Global Waste Generation in years 2016, 2030 and 2050

Source: Kaza, 2018

Fig 11b also showed that the second highest was paper and cardboard which was a large proportion of this waste, particularly in high income countries such as the United States as seen in the pie chart for global waste composition below. (Kaza, 2018).

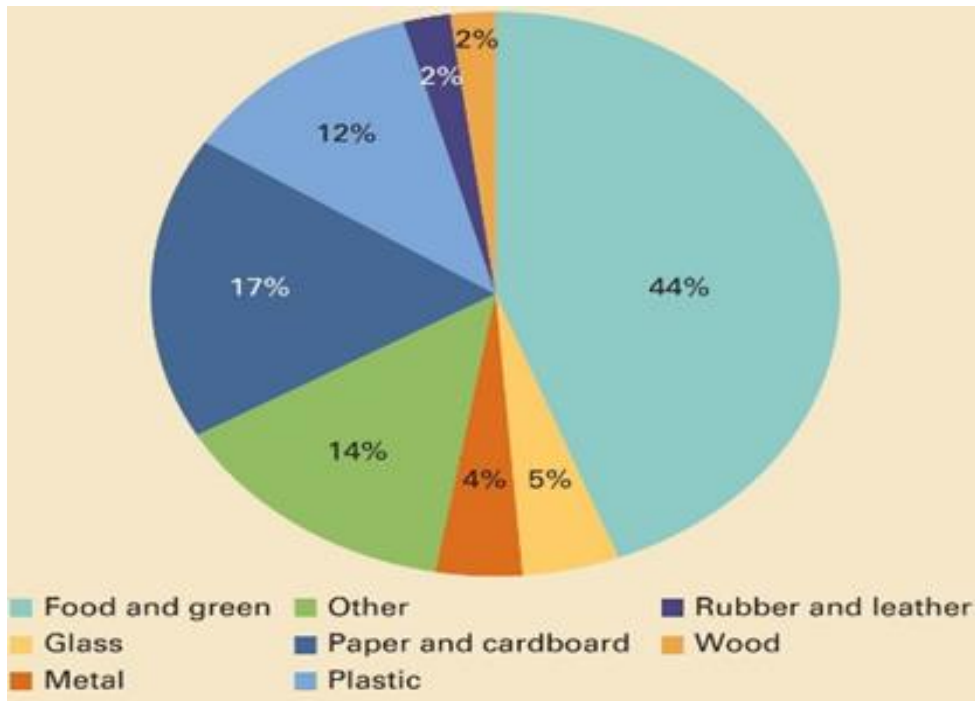


Fig 11b: Global Waste Composition by material

Source: Kaza, 2018

As seen in Fig 12a below, the current global waste generation is already higher in Asia than U.S. This could get even higher due to the current low per capita baseline for countries other than the U.S and to some extent Europe as seen in Fig 12b. Both Fig 12a and 12b demonstrate that there will be added pressure on U.S. as a global leader to decrease its share of Kraft Paper use.

In order to do this the U.S. has to invest in improving efficiencies by making legislative changes compelling these e-commerce companies such as Amazon, E-bay, Wayfair to invest in legal supply chains all the way to their sources so as to not unethically exploit the environment and to continually invest in recycling in order to promote the circular economy to avoid waste. (Halkous and Petrou, 2016).

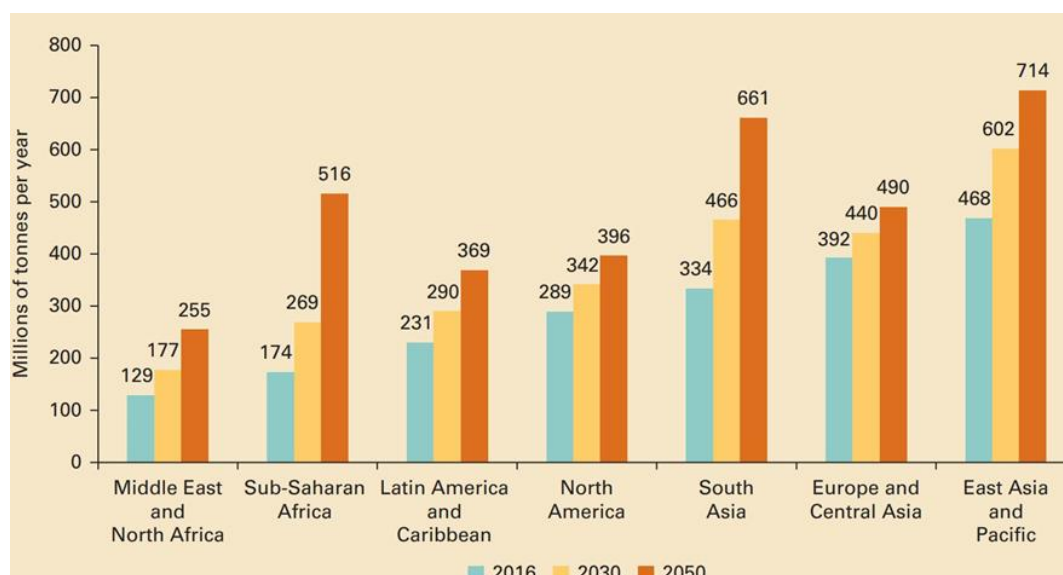


Fig 12a: Total projected global waste generation by region

Source: Kaza, 2018

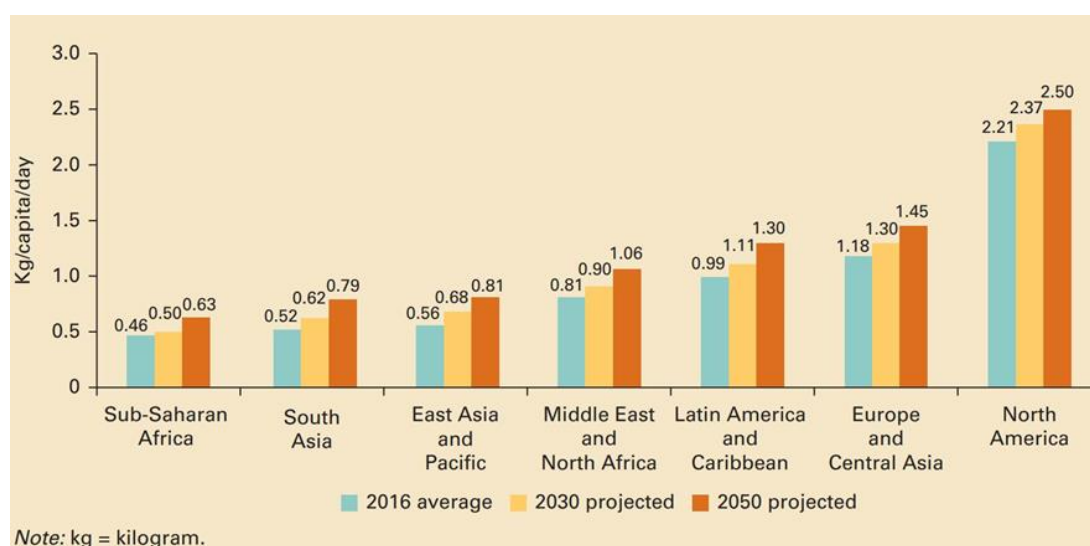


Fig 12b: Projected waste generation per capita for the years 2016, 2030 and 2050.

Source: Kaza, 2018

As observed below in Fig 13a are the rates of CO₂ generation for raw materials used to make paper. It could be seen that CO₂ generation in virgin sources especially such as northern softwood was the highest. Furthermore, despite the pulp production leading to the CO₂ generation another cause is the transportation cost, which can be prevented to a large amount.

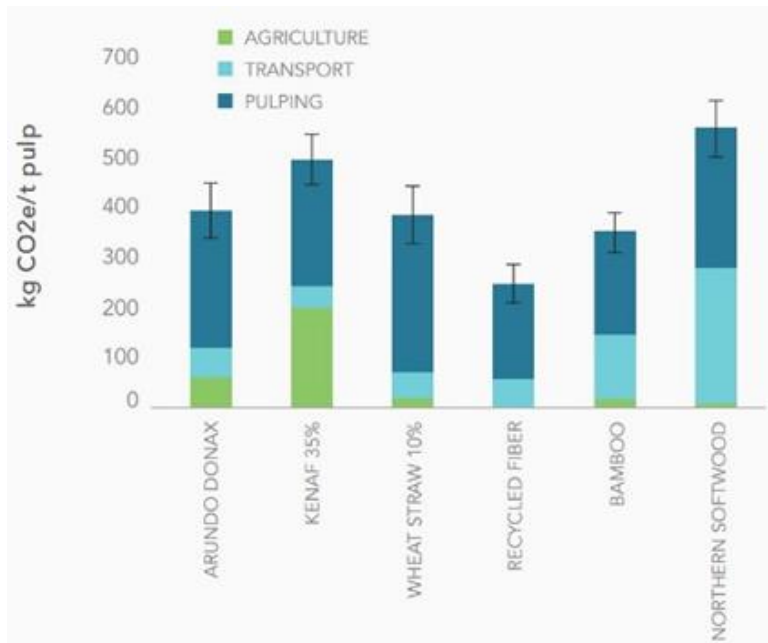


Fig 13a: Greenhouse gas emissions from fossil fuel and chemical inputs in production of pulp

Source: Haggith M., 2018

As discussed earlier, since a completely recycled packaging product would be less durable than virgin material sourced packaging, Fig 13a highlights that a combination of a lower CO2 generation virgin material such as bamboo or wheat straw with proximity to pulping location in combination with recycled fiber could yield a substantially lower CO2 generation packaging product than with the use of 100 percent northern softwood.

Fig 13b shows that despite recycled pulp fiber as source being the least polluting, large amounts of virgin pulp to the tune of 42 percent of total global pulp production are still being used. This demonstrates not only inefficiencies in the global supply chain systems but their uncoordinated nature also facilitating illegal manufacturing sources to enter this arena.

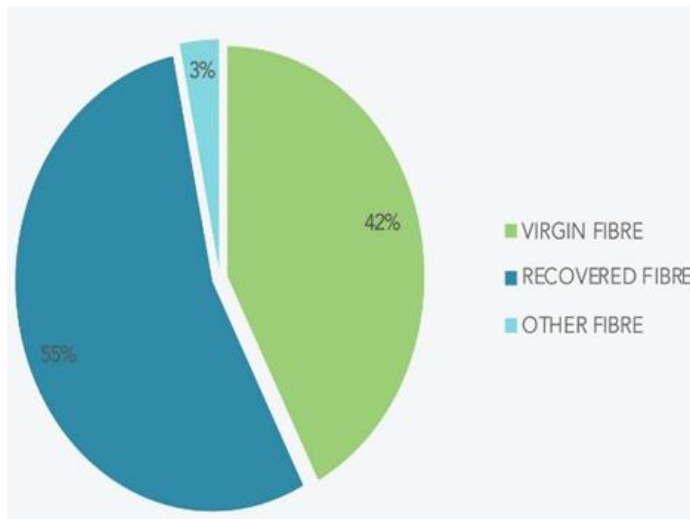


Fig 13b: Global pulp production by fibre source (2014).

Source: Haggith M., 2018

The amount of virgin material as a comparison could be seen in Fig 14 below which compares different regions of the world. It could be seen that recycling is starting from a much lower baseline in Northern America since two third of North American containerboard is made out of virgin and not recycled pulp. This could be due to the presence of a plentiful source of raw materials for the generation of paper. Another reason for the low use of recycled paper in packaging could be due to the need for boxes in U.S. having to travel longer distances than those in places such as Europe, thus leading to need for durable, longer lasting packaging boxes which consist of a higher proportion of virgin material as source than recycled material (De Pillis, 2019).

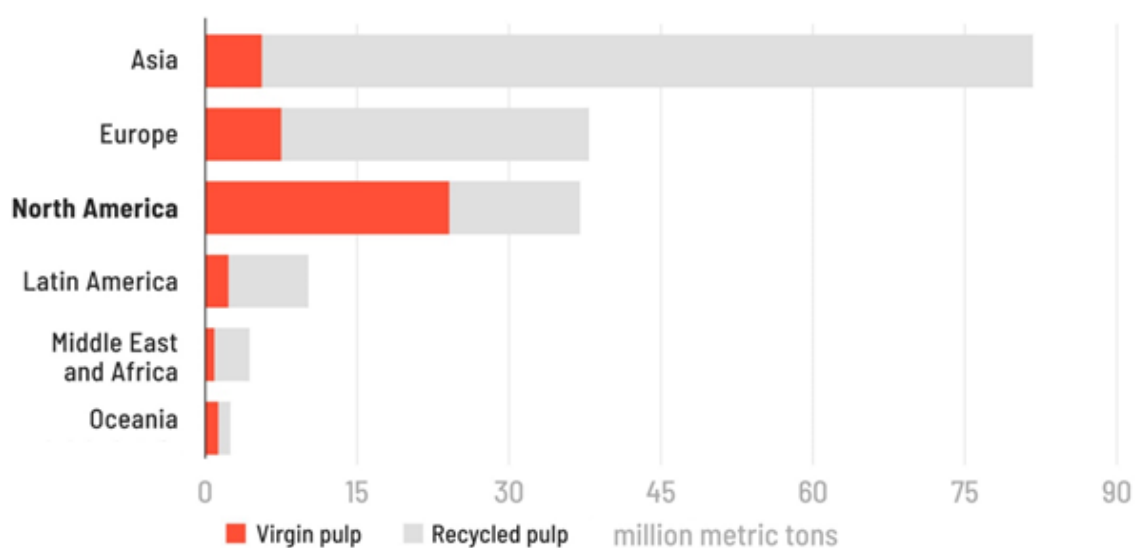


Fig 14: Source of pulp – virgin and recycled by million metric tons in the different continents of the world.

Source: Fastmarkets RISI, 2018

Another reason why virgin paper source could be high because in major developed countries such as in US, waste management services have been owned by private companies in collaboration with local governments and there isn't much incentive to recycle as opposed to shipping the waste out to other countries. However, with clampdown of this material going to foreign countries it would be imperative for U.S. to rethink the use of its recyclable pulp sources. This could be difficult to adapt to but could serve as the beginning for establishing new companies in recycled pulp bringing jobs and decreasing the cumulative CO2 emissions which are caused by use of virgin pulp material (Albeck-Ripka, 2018).

5.2 Future Study

It is paramount to find other ways to complement the advances being done in the delivery of products in the e-commerce industries such as Amazon, E-bay and Wayfair and understanding how the benefits in implementation could reduce resources such as containerboard being wasted by facilitating fewer materials heading to the landfill and companies increasingly adopting the circular economy.

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