

Visualisation of Plastic Data

Data Science Post Graduate Project (COS2667)

Industry Partner: Sustainability Victoria

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This report outlines the analysis and visualization of plastic data related to supply, demand, and waste management. It provides an insight into Australian industry's contribution in production, demand, and trade of plastic material along with recovery and management of plastic waste.

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Introduction

Industry Partner

The partner for this project is Sustainability Victoria. Sustainability Victoria's statutory objective is to facilitate and promote environmental sustainability in the use of resources. It is all about information, advice, and support to tackle climate change and use our precious resources wisely. Plastic being one of the most recognized material endangering the environment, this project is assigned to outline its flow in Australian economy.

Purpose of the Report

For many years now, plastic has become an integral part of our everyday lives. It is an easily available and painless solution for a plethora of everyday needs. The Plastic being a resource-efficient solution from its production to the placement on the market, it has surpassed most man-made materials after its large-scale production started in the middle of the 20th century. From packaging to machinery and equipment production, it is everywhere inspiring innovations that make lives better and safer every day.

Moreover, plastic plays a major role in the Australian economy. In 2019, the major producer of plastic product industries such as basic chemical manufacturing and polymer and rubber product manufacturing industries contributed up to 9.5% in employment. Also, the Australian waste and resource recovery sector contributed 0.5% in employment and 0.43% in GDP in 2016-17.

Apart from the extensive place plastic holds in our daily lives and global/national economy, its harmful impact on the environment is notable. The emerging plastic piles on our landfill and oceans are endangering marine life and pressing human health hazards. Some of the major hazards are the result of some extensively used plastic products that have a very short life span in the 'make-take-dispose' consumer model and end up in landfills due to poor waste management.

Considering the gravity of the issues and dependency of plastic, it is necessary to build more sustainable and resilient solutions that support the growth of future industries and reduce the detrimental impacts on the environment.

Scope and Limitation

The aim of this project is to provide a comprehensive analysis of the plastic life cycle in Australia. The combined study of plastic production, usage, and end-of-life fate is useful in understanding the flow of plastic materials in the Australian economy and identifying the gaps that are responsible for the issue of plastic waste. The extraction, exploration and visualization of open-source plastic data are performed to provide a summary of below-mentioned domains:

- Plastic value chain starting from production to consumption by industries across Australia
- Waste generation, and usage by industries followed by waste management via recycling, energy recovery, and landfill in all states
- How the widely used plastic packaging materials are managed
- Plastic trade, import, and export scenario in Australia

Using this analysis, the major areas, products, or industries to focus upon for improvising current challenges linked to the rapid growth of plastic use, the fate of mismanaged plastic, present plastic recycling, etc. can be identified.

The limitation of this analysis is the availability of open-source plastic data regarding plastic waste collection, recycling, and disposal in Australia. Also, the lack of historical data leads to challenges in exploring the trends of the plastic production-usage-dispose chain. The detailed supply, usage, and waste data are not available for recent years, making it difficult to analyze the current situation (Recently many initiatives are taken and policy changes are made to tackle the issues related to plastic waste).

Approach

To unfold the various factors involved in plastic life cycle, agile methodology has been implemented. Tasks are achieved by dividing the available time frame into integrations for each goal. Following are the major stages of agile life cycle:

- Deriving and validating a key domain involved in plastic life cycle which can have impact in making decisions
- Acquiring data from reliable source at global, national, and state level to build the analysis
- Detailed exploration of gathered data to derive key insights. Moreover, it is always needed to perform data validation to check if it aligns with previously achieved results. In case of inconsistency between acquired data and already achieved results, investigation needs to be performed to make changes accordingly. Finally, prepare all the validated data by wrangling and preprocessing to be used in the visualization tool

- Designing meaningful interactive dashboards in PowerBI to impact fully present the result using various data visualizations

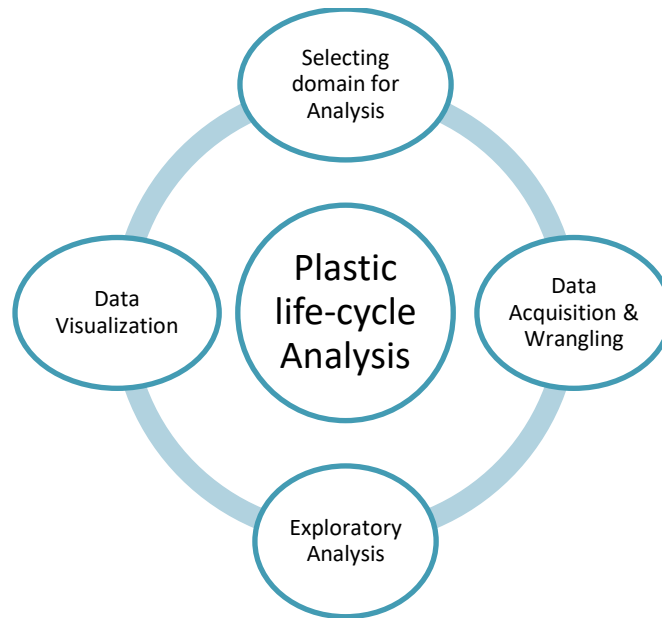


Figure 1 Plastic life cycle analysis Iterations

Plastic Production and Consumption in Australia (2016-17)

Implementation Methodology

To understand how plastic flows in Australian economy, the data from [1] is used from the tables of year 2016-17, having details of supply and usage of all products in Australian economy, and Australian Industries that are supplying and using these products. The supply and usage are measured in million dollars, supply is considered at basic price and usage is considered at purchase price for this analysis. Also, the industries used in source data are grouped into division and subdivision for analysis. Division refers to the major industry levels such as (Manufacturing, construction, health care, retail trade, etc.) and subdivision refers to the sub industries (For instance, polymer product and rubber manufacturing, basic chemical product manufacturing, food product manufacturing, etc. are the sub division of the manufacturing division). Also, only plastic and polymer products in Australian economy are considered.

Dashboard Details

Dashboard link:

PowerBI : <https://drive.google.com/file/d/1Dekr7n2HFZDqSAPhOSBIFBICEvIY4Abi/view?usp=sharing>

PDF-1 : <https://drive.google.com/file/d/1QLbkQnX8iH9gvBadu0wPAGnD5lyn-5-B/view?usp=sharing>

(Note: For all the dashboards, PDF is an alternative option only if unable to access PowerBi dashboards. PFD losses main feature of dashboards which is interactivity. Hence please consider PowerBi files as our main deliverables)

Dashboard highlight:

- The dashboard depicts total plastic supply and usage by industry divisions and subdivisions along with import, export and reexport (the export of foreign goods) proportions.
- The product-wise comparison of supply and usage is included to provide insights about the major products responsible for the rapid growth of total plastic usage.
- For each plastic product, the amount of product imported from trade partners, major local supplier industries of that product, major local consumer industries, and the amount exported can be seen by clicking on the product type.

Analysis & Findings

➤ Total Plastic Supply and usage by Major Industry Divisions:

Plastic Supply by Division

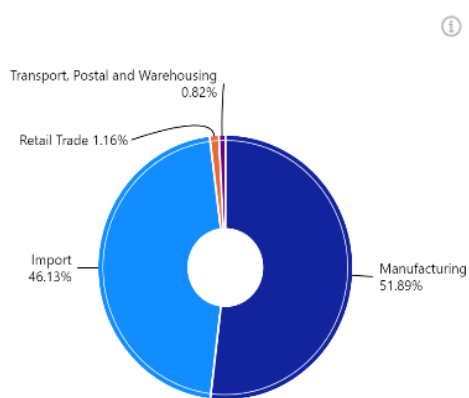


Figure 2 Plastic Supply by Division

Plastic Usage by Division



Figure 3 Plastic Usage by Division

The plot of plastic supply by Division shows that approx. 46% of total plastic is imported from the trade partners and 54% is locally produced. The major plastic product supplier and consumer is manufacturing division as it alone supplies up to 52% of plastic and uses up to 30% of the total plastic flowing in Australian economy. The other major divisions responsible for plastic usage are construction, household and government, wholesale trade, etc. Also, Approx. 5% of the total plastic is exported.

To further understand this flow of plastic supply and usage among manufacturing division, the subdivision plot is used.

➤ Total Plastic Supply and Usage by Manufacturing Subdivision:

Visualisation of Plastic Data

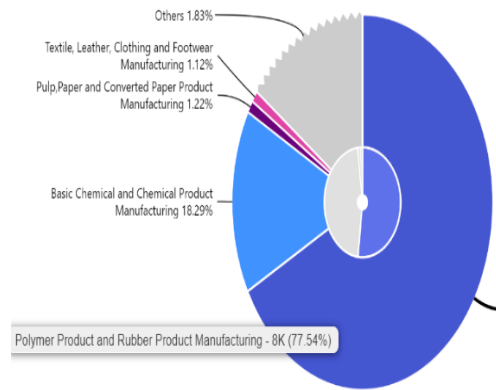


Figure 4 Plastic Supply by Subdivisions for Manufacturing Division

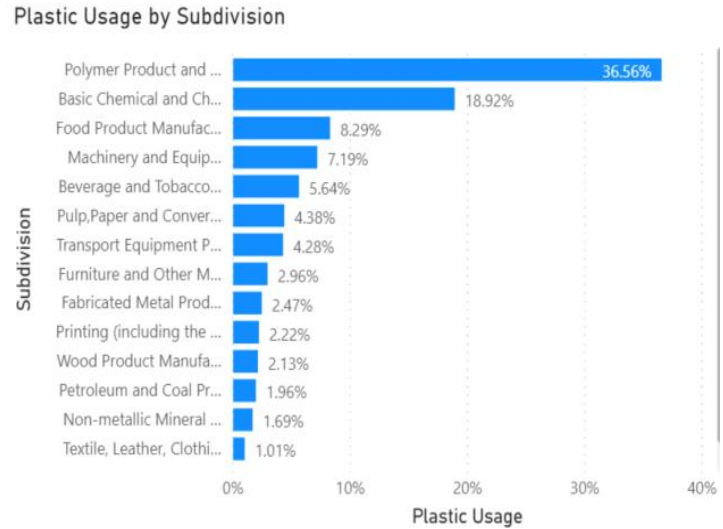


Figure 5 Plastic Usage by Subdivision for Manufacturing Division

The supply and usage plots of manufacturing subdivisions shows that the polymer and rubber product industry subdivision supplies upto 78% of the plastic, from which it uses upto 36% itself. The rest of the products supplied by this subdivision are used by other subdivisions such as food product manufacturing, machinery and equipment manufacturing, beverage and tobacco product manufacturing, etc. For instance, the polymer and rubber manufacturing is responsible for the production of polymer packaging materials, food wraps, bottles, etc., that are used by food product manufacturing and beverage manufacturing subdivisions. The basic chemical product manufacturing subdivision is also responsible for both supply and usage up to 19% (responsible for basic polymer production such as polythelene, polypropylene, polystyrene, etc. that are further used as a raw material to produce other rigid and semi-rigid products, plastic foam products, etc.).

➤ Plastic Usage by material type:

Now, the plastic products that are supplied and used the most in Australia can be inferred from below plot.

Visualisation of Plastic Data

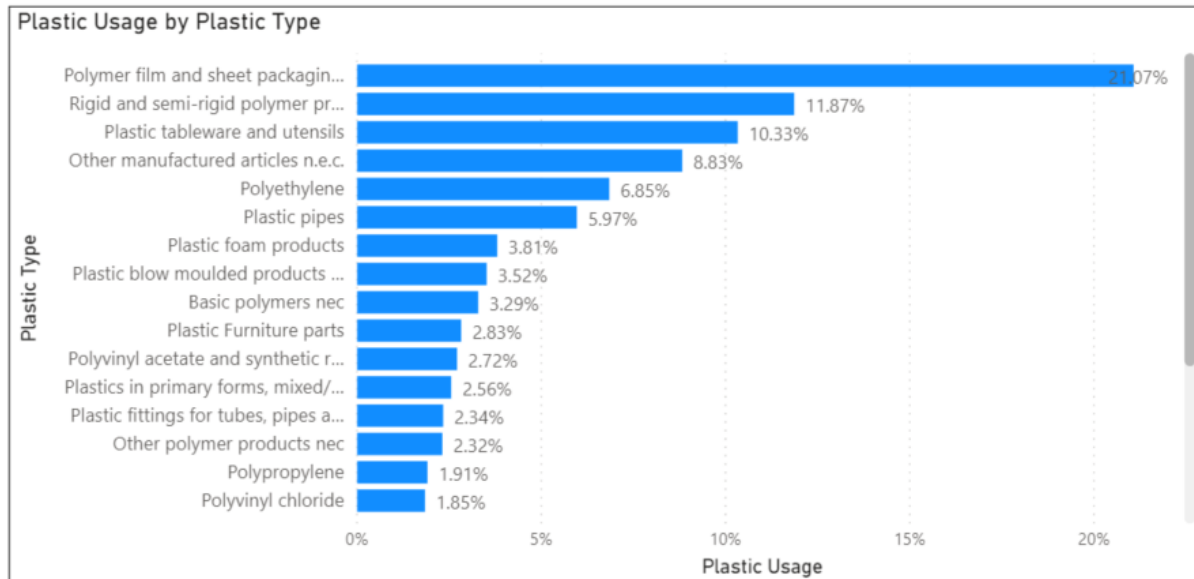


Figure 6 Plastic Usage by Material Type

The above plot shows plastic product groups by its contribution in plastic usage. It shows that polymer film and sheet that are used for packaging purposes alone accounts for approx. 21% of plastic consumption. This 21% of packaging material consist of products like plastic bags, garbage bags, food wraps. These are mostly single used plastic materials contributing the most into plastic waste. The rigid and semi-rigid plastic products also dominate up to 12%. This group mainly consists of products such as bottle, buckets, cloth pegs, light switch and plugs, plumbing fittings, watering can.

➤ Plastic Supply vs Usage:

The below plot shows overall comparison of plastic products with supply and usage proportions. This depicts the similar products dominating the supply and usage Australia-wide.

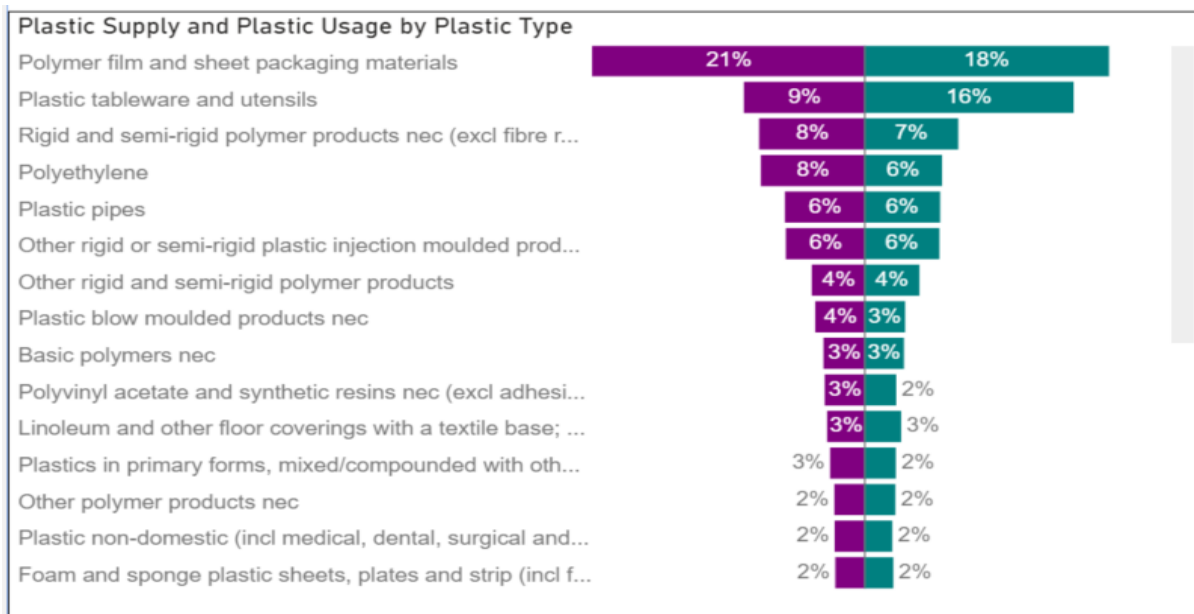


Figure 7 Plastic Supply vs Usage by type of plastic

➤ **Dashboard view of Polymer Film and Sheet Packaging materials, and Plastic Tableware and Utensils:**

Now, as all the plots described above are interlinked with each other, each plastic product can be explored for its supply and usage as shown in below dashboard view of polymer film and sheet packaging materials.

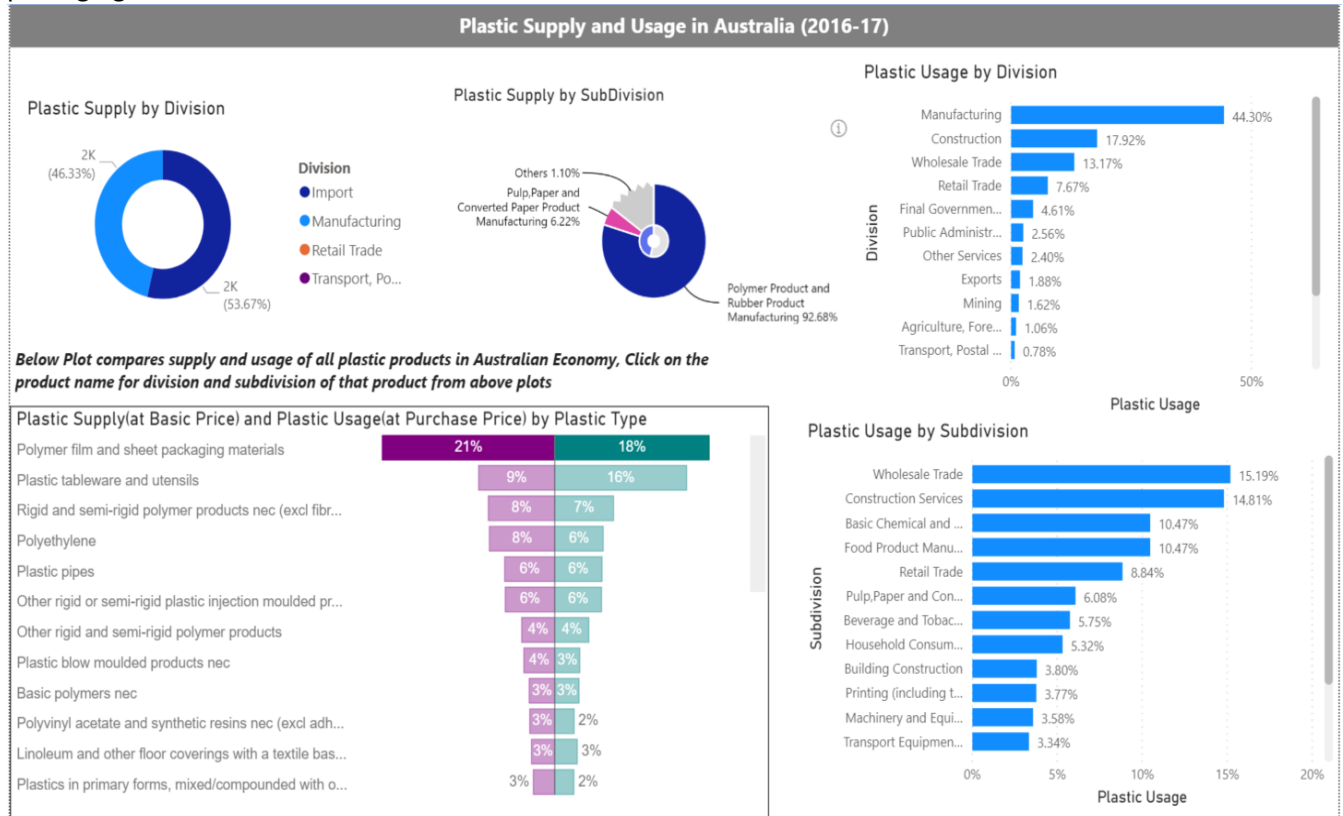


Figure 8 Plastic Supply & Usage Dashboard's view for Polymer film and sheet packaging material

It shows that approx. 54% of packaging materials are imported and rest 46% is locally produced by manufacturing division. The polymer and rubber product manufacturing subdivision supplies the most polymer film and sheet packaging materials followed by pulp, paper and converted paper manufacturing subdivision. This product is used the most by manufacturing, construction, and wholesale divisions and only 2% is exported. The subdivision plot further shows the main usage by manufacturing subdivisions such as basic chemical product manufacturing, food product manufacturing, etc after wholesale trade and construction services.

Similarly, the insights of plastic tableware and utensils can be seen from below snapshot of dashboard view. Approximately 54% of it is imported and 46% is locally manufactured. Major manufacturer is polymer and rubber product manufacturing subdivision (99%). It is mainly used by government and household division which can be justified by highly used disposable tableware and utensils in everyday lives.

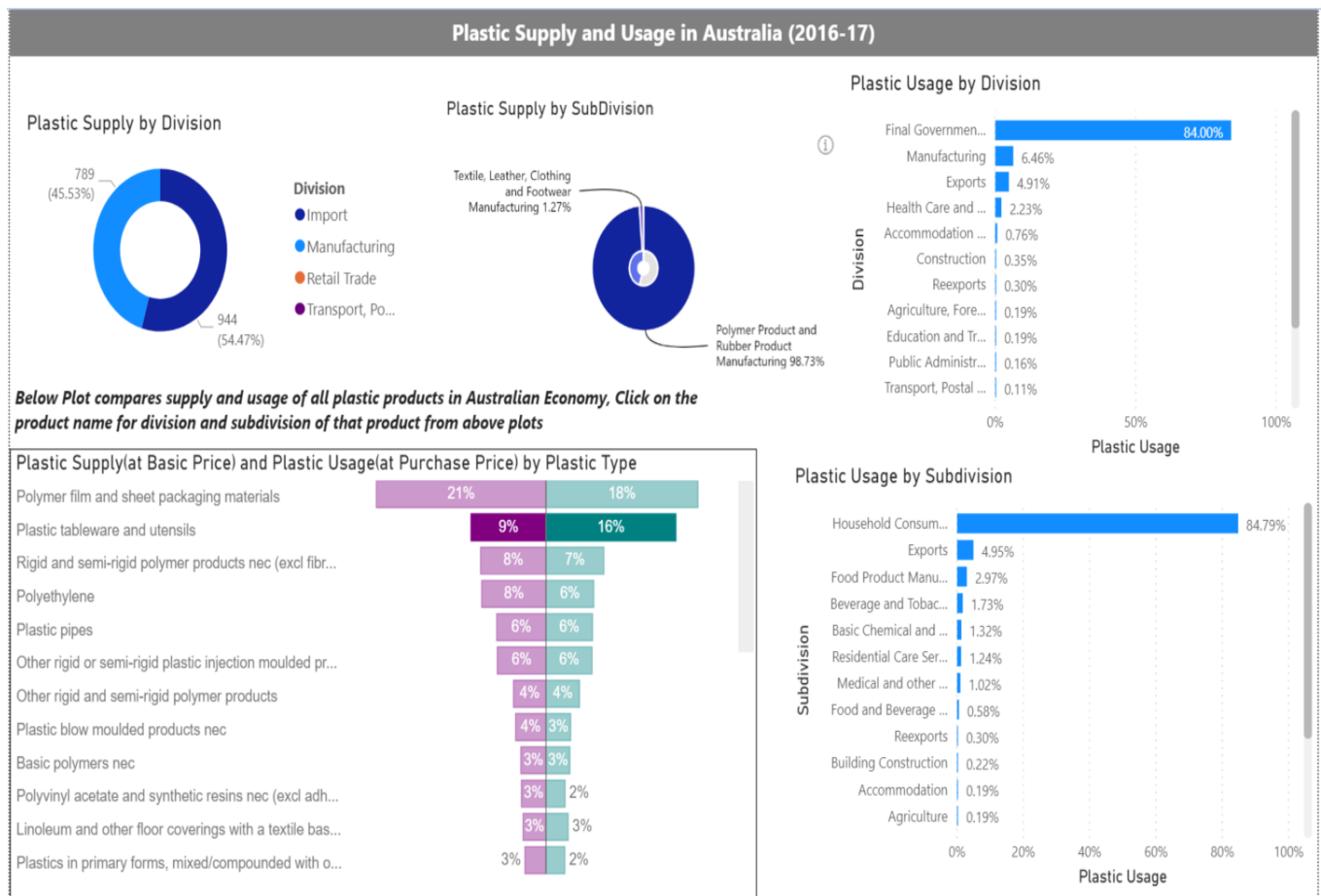


Figure 9 Plastic Supply & Usage Dashboard's view for Plastic Tableware and Utensils

Plastic Waste Analysis

The goal behind conducting plastic waste management study is to provide comprehensive details of various types of reprocessed plastic products across Australian recycling facilities. It is crucial to study the fate of all the collected waste. Out of all the collected plastic waste in Australia, only limited quantity gets recycled. In this section, plastic waste supply and usage draws attention on area where efforts are needed to be made. Plastic waste can be treated in 3 ways: landfill, recycling, and Energy recovery. After certain changes in waste trading policies with foreign countries, Australia must look up for alternative ways to manage own waste and reprocess it internally. The data and finding of this section can potentially highlight the gaps in plastic waste recovery process.

Implementation Methodology

The source data used for this analysis is of year 2016-17 [2]. The data collected by ABS waste account has information of plastic waste supplied by and used by different industries. Plastic materials flowing in Australian economy are segregated in 7 grades of plastic for waste management. For the analysis of plastic waste usage and supply, we have grouped them into 4 basic polymer categories (Polypropylene, Polystyrene, Polyethylene, and Polyvinyl Chloride).

For micro level analysis, each Australian state's share into consumption and recovery of plastic is presented in the dashboard. Moreover, number of reprocessor facilities of major polymers of plastic is available. National waste database has state-wise data recorded from 2007-2017 deriving the fate of the plastic waste, which is landfill or recycled. The complete view of dashboard can significantly highlight the gap in plastic consumption and its recycling capability of each state across Australia for various plastic polymers.

Dashboard Details

Dashboard link:

a) Waste Supply and Usage Analysis

PowerBI: https://drive.google.com/file/d/1UfesDih_-BYRbkpIHSQNEJW4haOWNHO8/view?usp=sharing

PDF-2 : <https://drive.google.com/file/d/1guoW4-ht9VMHS93OmUZTD35keZh5VuSG/view?usp=sharing>

b) State-wise waste management Analysis

PowerBI: <https://drive.google.com/file/d/1PkDyVTNNfegQAiSy1VFYAj-dt1-eQaKo/view?usp=sharing>

PDF-3: <https://drive.google.com/file/d/1tXLl41puFSTnfQYpgVyppM8q202W-jcc/view?usp=sharing>

Dashboard highlight:

a) Waste Supply and Usage Analysis

- Plastic type wise: Plastic waste supply and usage by industries across Australia, plastic waste treatment type
- For Victoria only- Industry stream wise (MSW, C&D, C&I) scenario of recycling & landfill

b) State-wise waste management Analysis

- State wise: Number of reproducers, consumed & recycled plastic, overseas export of plastic waste, Recovery rate
- State wise recycling and landfill scenario over past 10 years
- Plastic type wise: consumption vs recycling, and recovery rate for each state, Number of reproducers

Analysis & Findings

a) Waste Supply and Usage Analysis

For this section, all the visualizations are created on data of major 4 plastic types which are grouped as mentioned above. Only key findings are discussed, however interactive dashboard enables you to explore all the possible factors for all 4 plastic types.

➤ **Plastic waste supply and usage:**

Following tree map represents industries which supplies plastic waste for treatment and industries which uses collected plastic waste for all 4 polymer types.



Figure 10 Plastic Waste Supply and Usage by Industries

Considering 'post-consumer use' waste, Household (54%) supplies the most amount of plastic waste followed by Manufacturing (31.23%) industry. Some other industries like Electricity, gas & water services; Construction; Mining also contribute to the total supply of plastic waste for treatment. Usage graph shows the industries using waste which has not been treated (waste not going into landfill, recycling, and energy recovery). Majority of this remained plastic waste is exported (36.38%) to other countries in either resin form or unprocessed form. Construction industry uses remarkable proportion of remained waste by 25.33%. Manufacturing also uses a small portion of 3.54% of waste which is far less than waste supplied by the same.

➤ **Waste treatment based on plastic polymer type:**

Here, waste treatments are in the form of landfill, recycling, or energy recovery. The common pattern identified for all the plastic polymers is higher landfill disposal of waste than recycling and energy recovery.

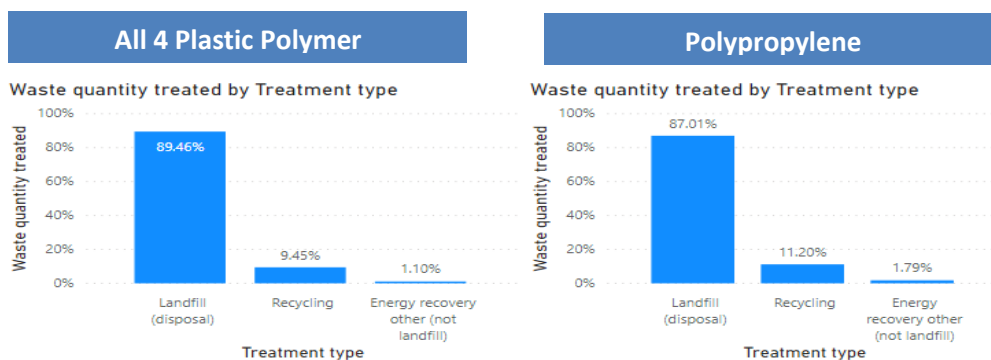


Figure 11 Waste treatment based on Polymer Type

➤ Waste Supply vs Usage by Industries:

Following graph allows industry-based comparison of plastic waste supplied and used by the industry. Construction is the only industry here which uses more plastic waste than it generates.

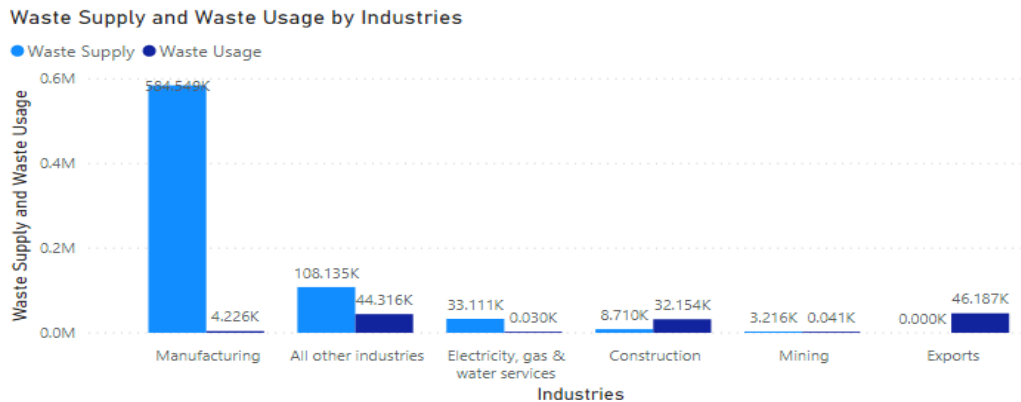


Figure 12 Plastic Waste Supply and Usage by Industries

➤ Recycling and Landfill in Victoria:

Now, As depicted in earlier analysis that the end-of-life fate of Post-consumer plastic waste is mainly recycling and landfill, below plots depicts the trend of recycle and landfill in Victoria, segregated by waste source streams (that are, MSW- Municipal Solid Waste, C&I - Commercial and Industries, C&D - Construction and Demolition).

Below Visuals represent Recycling and Landfill scenario in Victorian Industry Streams for past 10 years

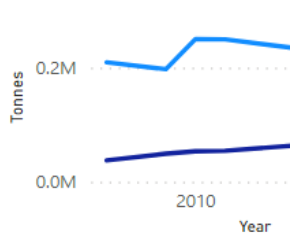
C&D : Construction and Demolition

C&I : Commercial and Industrial

MSW : Municipal Solid Waste

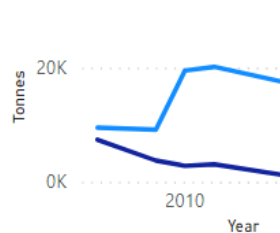
MSW Recycling and Landfill

Manage... ● Landfill ● Recycling



C&D Waste Recycling and Landfill

Manag... ● Landfill ● Recycling



C&I Waste Recycling and Landfill

Mana... ● Landfill ● Recycling

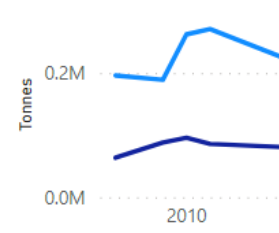


Figure 13 Landfill and Recycling trend in Victoria

All the plots show the high amount of waste ending up in landfill. Also, the plots of MSW and C&I show a slightly decreasing trend in recent years for landfill, indicating improvement in waste management. However, the recycling shows very less increment in MSW and no improvement in C&I.

On the contrary, the C&D stream plot shows that the amount of C&D waste ending up in landfill is increasing and recycling amount is decreasing. Although very less amount of C&D waste is flowing as compared to other streams. MSW waste consist of the plastic material with very short life span such as single-used plastic. On the other hand, C&D plastic products are the one that usually have longer life span. Therefore, very less plastic waste is contributed via C&D per annum.

b) State-wise Waste Management Analysis:

➤ State-wise comparison:

Below figure depicts state wise overall analysis of plastic waste consumption, Reprocessing facilities, waste recycled in Australia & overseas. Color intensity of the state in map indicates recycled plastic quantity. This map empowers study by allowing comparison of major factors in 2016-17 across Australian states. The major factors compare in the map can be describes as follow:

- Recycling Quantity: Total plastic recycled in tonnes
- No of Reprocessor: Total reprocessors in a state for all types of plastic products
- % of Recycling Contribution: State contribution in Australian total recycled plastic (in %)
- % of Recyclate Overseas Contribution: State contribution in total Australian plastic recyclate exported overseas (in %)
- % of Consumption Contribution: State contribution in total plastic consumption (in %)
- State Recovery Rate: Recovery rate of state with regards to % of waste recycled out of total consumption

It can be inferred from the colors that; Victoria and NSW are the top states contributing to recycling. This can be justified by the high population in these states. Victoria accounts for 41.67% of overseas recyclate export, 38.94% recycling and 25.71% consumption of total country level factors. All these leading to Victoria's plastic recovery rate of 17.90% which is highest among all the states.



Figure 14 State wise recycling trend across Australia

➤ Landfill vs Recycling trend of Australian states:

State wise plastic waste treatment trend from 2007 to 2017 is put together in below plot. Waste treatment is shown in either landfill or recycling form. The final goal should be to minimize the distance between two lines in the graph, i.e. lower landfill, and higher recycling.

Overall Australia's plastic waste treatment scenario has not changed much. However, Victoria has been successful in reducing plastic landfill after 2015. Victoria has not achieved any significant result in increasing plastic recycling till 2017. Although South Australia is dealing with very low amount of waste, it can be seen in the graph that over the year landfill has reduced along with increase in recycling. This shows a good waste management practice.

There are various barriers in recycling plastic like less efficient reprocessing techniques, very low market demand for recycled products in Australia. Research indicated that Australia holds capacity to recycle 10 times more plastic than currently recycled quantity. But the raw waste or final recycled product has very limited market available in the country. That diverts plastic waste to foreign countries.

Visualisation of Plastic Data

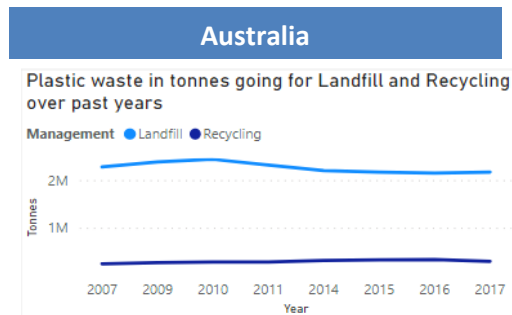


Figure 15 Plastic landfill vs recycling trend of Australia



Figure 16 Plastic landfill vs recycling trend of Victoria

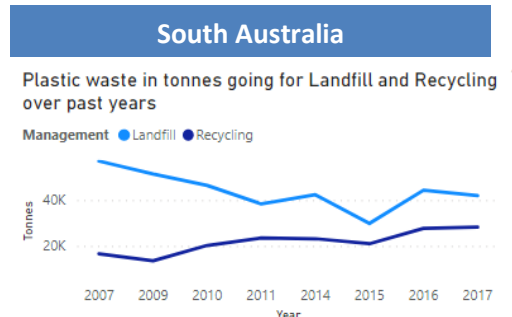


Figure 17 Plastic landfill vs recycling trend of South Australia

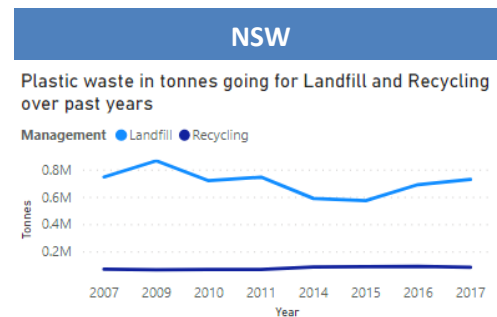


Figure 18 Plastic landfill vs recycling trend of NSW

➤ Reprocessors based on plastic type:

Australia has total 152 reprocessors across entire country. This is further segregated in the states and plastic products. Evidently, Victoria is leading in the number of available facilities followed by NSW and Queensland. Comparatively higher number of reprocessors are available for Polyethylene High Density - Low Density and Polypropylene as compared to other plastic types. Combined 24 Victorian reprocessors can recycle all the given plastic products. (Note: Data for South Australia's reprocessors is not available)

Visualisation of Plastic Data

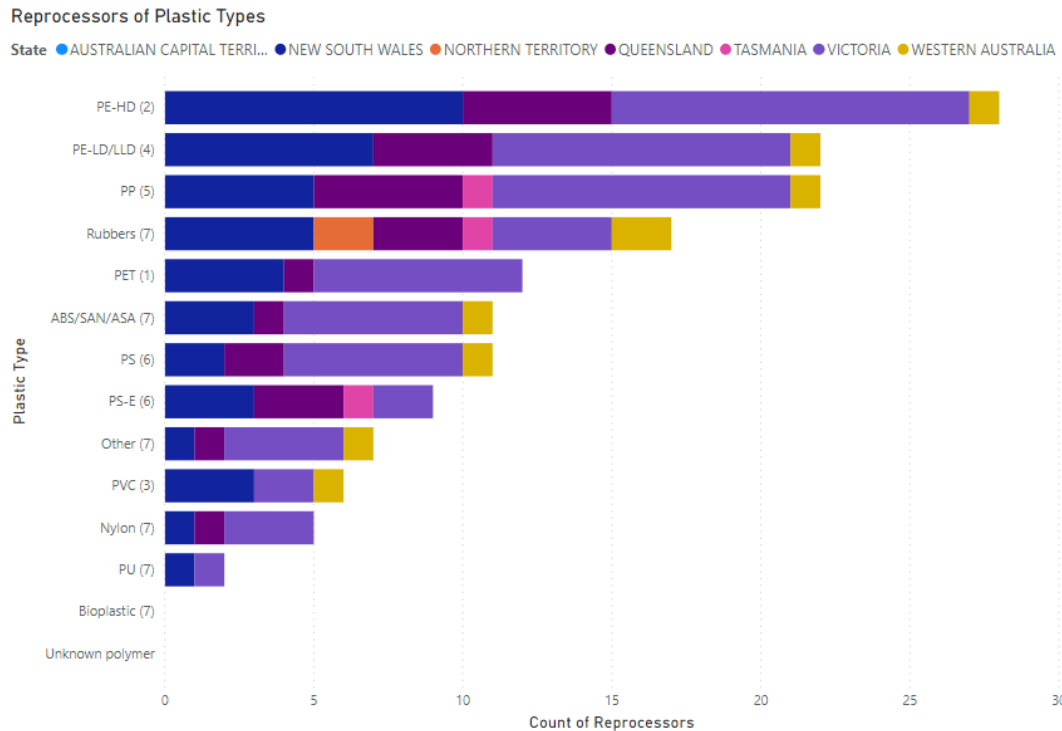


Figure 19 Number of reprocessors based on plastic type across Australian states

➤ Plastic Consumption vs Recycling, Recovery rate based on type:

In 2016-17, only 11.8% of total consumed plastic across Australia was recycled. This total recycled plastic consists of direct plastic waste sent to overseas, local reprocessing for local use and local reprocessing for overseas export in proportion of 36%, 7% and 57% respectively.

A clustered bar chart with line graph is an indicator of plastic type-based consumption, recycling, and recovery rate. The below graph has cumulated information for entire Australia which can be filtered out for state.

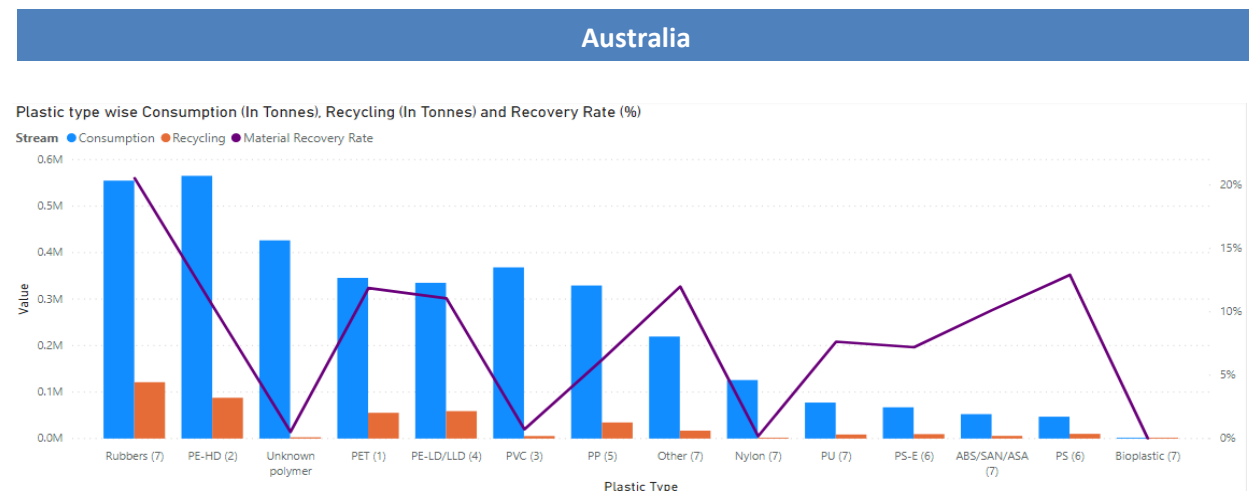


Figure 20 Plastic consumption vs recovery, and recovery rate based on plastic type across Australia

Visualisation of Plastic Data

Rubber, Polyethylene (PE-HD, PE-LD/LLD), Polyethylene Terephthalate (PET), Polyvinyl Chloride (PVC) and Polypropylene (PP) are highly consumed plastic types. Only 20.53% of total consumed rubber is recovered. PE-HD has recovery rate of only 10.49%. As compare to consumption, very negligible quantity of the plastic gets recycled. Recovery rate values for all products lie between highest of approx. 21% to lowest of >1%. The critical aspects leading to lower recovery rate are poor waste collection, complexity of waste segregation and high quantity of contaminated waste.

Now, below graph depicts Victoria's scenario.

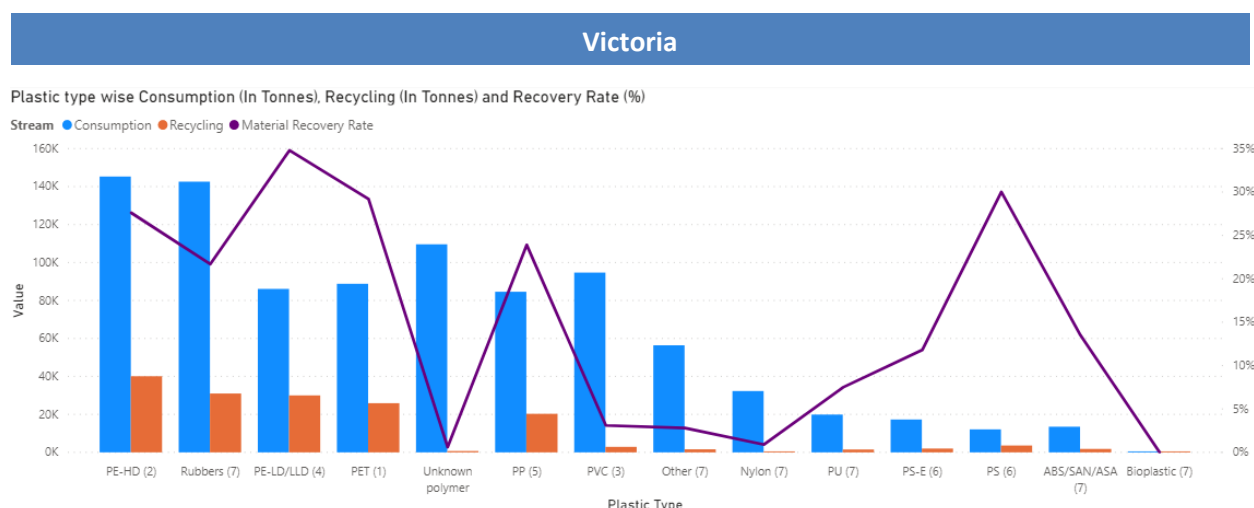


Figure 21 Plastic Consumption vs Recovery, and Recovery Rate based on Plastic Type across Victoria

Victoria has high consumption of plastic types like PE-HD, Rubbers, PVC, and PE-LD/LLD. Recycling of these types is considerably in a good shape due to established reprocessing power. Therefore, more used plastic types across Victoria also have higher recovery rate.

Plastic Packaging Scenario

It is observed in the supply-usage analysis in the above sections, plastic packaging products such as polymer films and sheet packaging materials which are primarily used for bags, sack or packets, lamination and bubble packages has highest supply and consumption values. Hence, this section will provide comprehensive understanding of plastic packaging system in Australia.

Australia's sustainable approach for changing packaging waste management is fueled by the announcement of 2025 National Packaging Targets. To meet this target, flow of packaging in supply, usage and waste treatment establish a baseline of required innovations in the field. This paradigm shift is driving Australian consumer, government, researchers, and industries to accelerate packaging ecosystem model redesigning process. [6] Developing circular economy of packaging demands a shift from 'take-make-dispose' model to a circular model that promotes reusability of plastic.

Plastic packaging products are integral to modern lifestyle. Being a light weight and low-cost material available in various forms, plastic has rapidly increased usage in past few years. Most of the plastic

packaging are of single use plastic and have fast supply to waste flow as compared to other packaging materials. Cumulative analysis of all the aspects in this section explores fundamental gaps in the end to end packaging system. Most importantly, packing waste is a poorly characterized waste material stream in Australia.

Implementation Methodology

The data used for plastic packaging dashboard is of year 2017-18 collected and managed by Australian Packaging Covenant Organization (APCO) [5]. To develop understanding of this dashboard, few terms are needed to be explained first. POM is 'placed on market' which stands for the product made available to the end customers like business and consumers. After intended packaging use, subsequent disposal is referred as 'post-consumer disposal'. Packaging losses which are even prior to the point it reaches market (POM) are called 'pre-consumer' losses.

Packing dashboard covers plastic packaging overall supply and recovery, major products, polymer types, recovery rate, material structure-based comparison and industry-based comparisons across Australia. In the dashboard, POM term is referred as supply to make it more understandable for any user.

Dashboard Details

Dashboard link:

PowerBI: <https://drive.google.com/file/d/1cZiVgt-6l21oapAfuPOjGt2AqzKDnr/view?usp=sharing>

PDF-4: <https://drive.google.com/file/d/1ZUhDox9LYWaNpobWADwHiQ5FMshGwcsM/view?usp=sharing>

Dashboard Highlights:

- Major plastic products in packaging
- Plastic type wise: Market for plastic packaging, usage and recovery, Flexible and rigid packaging material recycling rate, recovery in each industry stream

Analysis & Findings

In 2017-18, around 1.1 million tonnes of plastic packaging was placed on market (POM) which is 19.6% of all type of packaging supplied.

Table 1 Plastic Supply and Recovery in Packaging Domain

Composition	Plastic Packaging	% of plastic in total packaging	Total Packaging
POM (Supply)	1067000 (Tonnes)	19.6%	5453000
Recovery	173000 (Tonnes)	6.5%	2673000
Recovery Rate of plastic in packaging	16%		

➤ Major plastic packaging product Usage:

Visualisation of Plastic Data

Below given funnel chart shows each product's share into total plastic packaging supply to the market. Bottles and jars are the highest supplied products followed by bags, liners, wraps and film seals. Bottles and jars alone are around 35% of all the plastic packaging products.

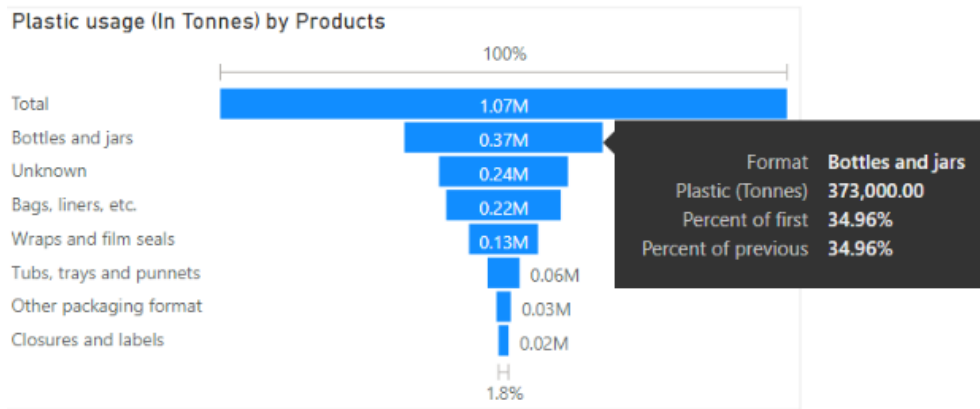


Figure 22 Packaging Products Usage

➤ Markets of plastic packaging supply based on Material Type:

Now, total plastic packaging products are mainly placed on market for two sources: Business to business (B2B) or Consumer. APCO collected data for market evaluation across source of plastic packaging material types is given in below stacked bar chart. Plastic packaging of 287k tonnes (27% of total plastic packaging) is distributed in B2B. Whereas 689k tonnes (65% of total plastic packaging) of the same goes into Consumer market. For rest 91k tonnes, mapping is unidentified.

HDPE (32.9%), LDPE (23.8%) and PP (15%) dominate plastic packaging consumption. HDPE and LDPE are used in rigid packaging applications. B2B category mainly uses LDPE and HDPE. LDPE is generally used in shrink wrap, stretch films and container lids.

Plastic packaging supplied in Consumer markets are of HDPE, PP, PET and LDPE. Major products of HDPE in packaging are grocery bags, plastic bottles, cereal box liners for consumers and extruded pipes for B2B. Polypropylene can be used to make bottle caps and medicine bottles.

Visualisation of Plastic Data

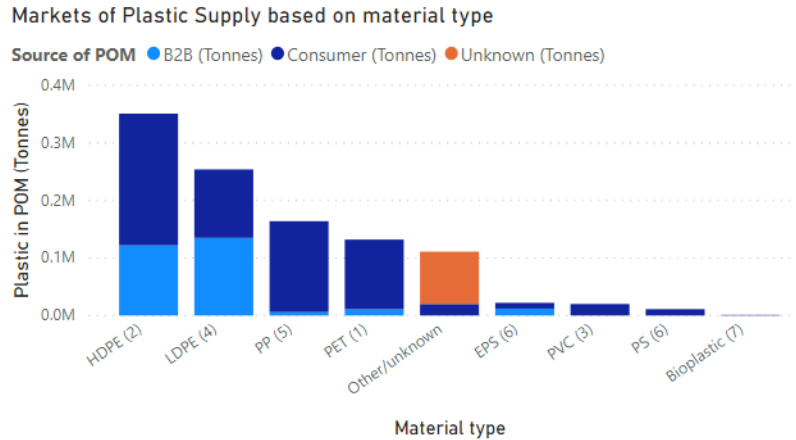


Figure 23 Markets of Plastic Packaging Supply based on Plastic Type

➤ Plastic Supply vs Recovery:

So far characteristics of plastic packaging material supplied in Australian economy has been discussed. Now, treatment of the plastic packaging waste will be discussed. Plastic packaging supply and recovery analysis for various plastic types is fundamental step to rectify changes required to enhance performance of circular packaging model. Recovery rate of HDPE and PET is high as compared to other plastic types.

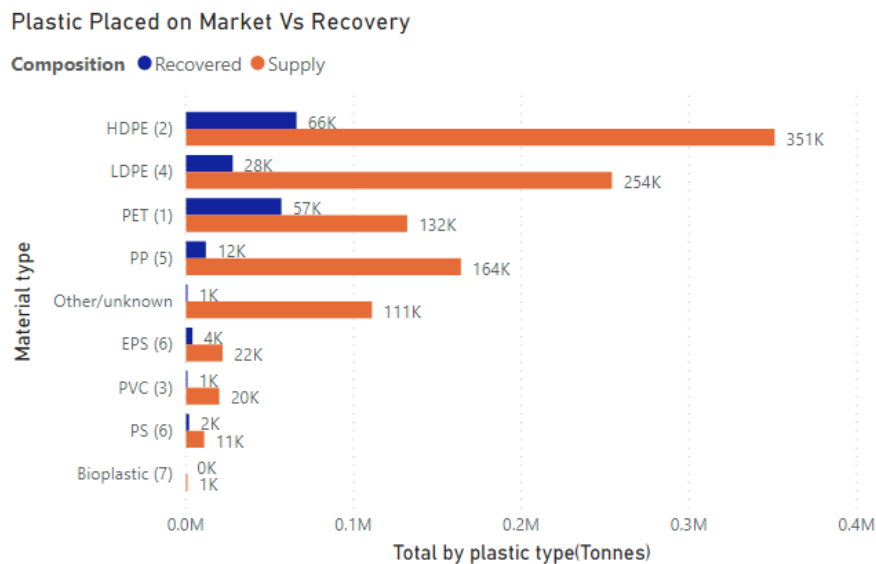


Figure 24 Plastic Packaging Supply vs Recovery based on Plastic Type

Major application of recovered plastic materials from packaging are as follow:

- HDPE: Films, pallets, Irrigation hose and pipes, wheelie bins, cable covers, wood substitutes
- PET: Beverage bottles, pallets and fence pots, geo-textiles

Visualisation of Plastic Data

- LDPE: Film including concrete lining, builders' & agricultural film, garbage bags, binder additive to asphalt, irrigation tube
- PP: Crate boxes and plant plots, electrical cable cover, building panels and concrete reinforcement stools, builders' film
- EPS: Waffle pods for under slab construction of buildings, insulation sheeting, lightweight concrete
- PVC: Pipes, floor coverings, hose applications and fittings
- PS: Industrial spools, building components, building components, glass, coat hangers

➤ Plastic packaging Supply and Recovery composition based on plastic structure type (Rigid or Flexible):

Plastic packaging format can be categorized into rigid and flexible. Rigidity of plastic can help determining the recoverability and value of the material. By rigid plastic packaging, products like bottles and tubs, which are usually moulded and have characteristic of holding their shape. Whereas flexible plastic packaging term is referred for the goods which can be soft and can be crunched.



Figure 25 Rigid Plastic Supply vs Recovery in Packaging

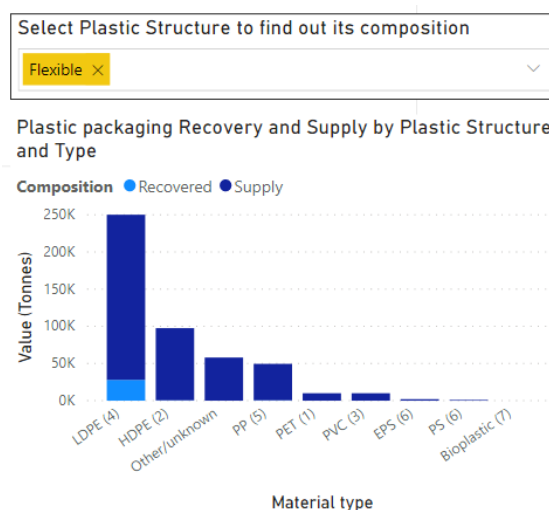


Figure 26 Flexible Plastic Supply vs Recovery in Packaging

Out of total plastic packaging supplied in 2017-18, 45% supplied was identified as rigid and 33% supplied was identified as flexible plastic. Major rigid plastic packaging products supplied are made from HDPE (Applications like crates and tray), PET and PP.

Out of total plastic packaging recovered in 2017-18, 83% were rigid plastic packaging, and 17% flexible plastic packaging. Recovery rates for rigid plastic packaging products of HDPE and PET are considerably good than other types. Whereas collected data has only identified LDPE for flexible plastic packaging product recovery.

➤ Plastic packaging recovery by Plastic type and collection Industry Stream:

Visualisation of Plastic Data

Now, collection industry stream wise composition of all the recovered plastic packaging materials is presented in the below given graph. Collection industry streams considered for comparison are MSW, C&I, and C&D. For collected recovered plastic waste, MSW dominates all other streams followed by C&I. MSW has waste of mainly HDPE, PET, PP., and PVC plastic types.

C&I industry collected recovered plastic waste mainly includes products made of LDPE, HDPE, and EPS types.

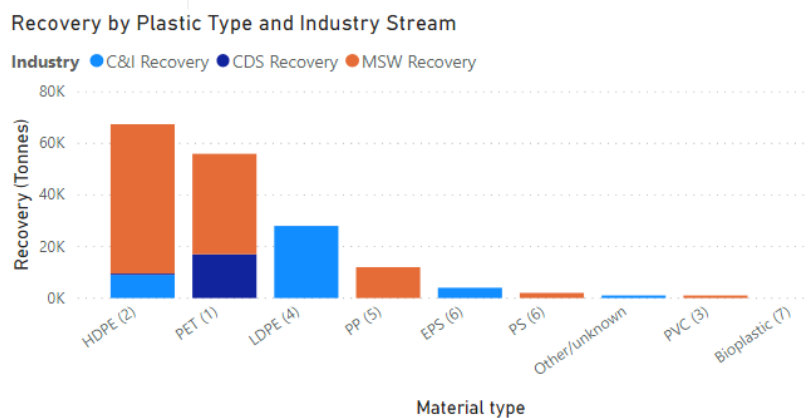


Figure 27 Recovery of Plastic Packaging by type and collection industry

Plastic Import, Export and Trade Scenario:

Implementation Methodology

The data for plastic Import and Export along with all trading partner countries are extracted from [4]. The data source contains information about all commodities from four broad sectors that are, Agriculture, forestry, and fisheries; minerals and fuels; manufacturers; and other goods. Among these products, data for the polymer/plastic products are extracted and explored to understand overall plastic import, export, and trade. To check the trend of import and export, data from past 12 years is extracted and plotted in a single dashboard providing functionality to explore trade balance, import and export. Also, the top trading partner countries for each plastic product can be inferred from this analysis.

Dashboard Details

Dashboard link:

PowerBI: <https://drive.google.com/file/d/157vNGdp64VwfgRY93XzFf82cLGtTstGk/view?usp=sharing>

PDF-5 : https://drive.google.com/file/d/1VV5xnZyr7GB8VLvikMixrSb0m_4qL0tV/view?usp=sharing

Dashboard Highlights:

- Trade balance of plastic over past 12 years
- Plastic type wise: Import & export over past 12 years, top trading partners(countries)

Analysis & Findings

➤ Plastic Export, Import, and Trade balance Trend:

The increasing trend in import and trade balance justifies the growth of plastic consumption in Australia, coupled with population growth over past 12 years. However, the export scenario remains stable over the time.

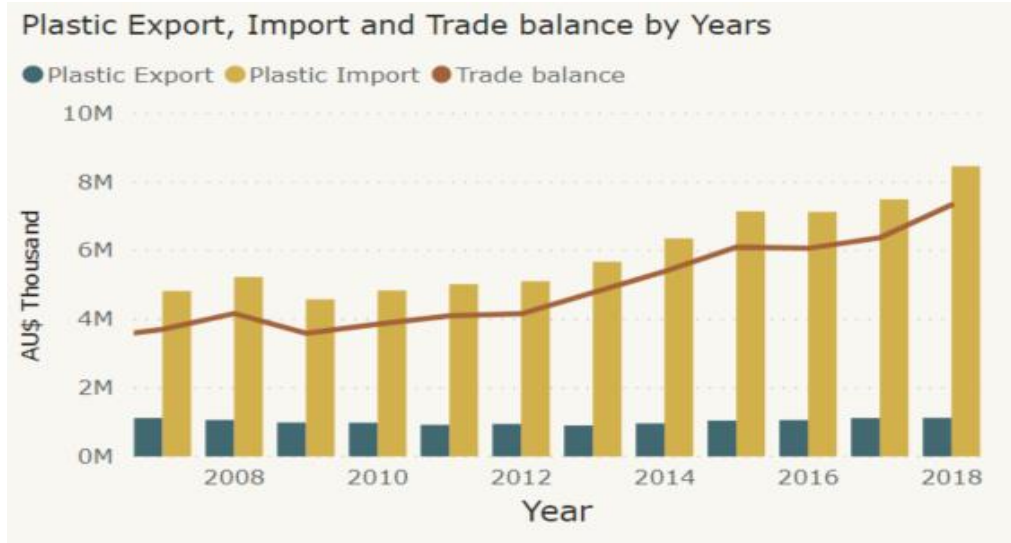


Figure 28 Plastic Import, Export, and Trade balance Trend

➤ Plastic material wise Import and Export Trend:

Now, plastic material wise import can be tracked using below plot. The trend for the import is nearly same during past years for all the products. It shows that plastic articles, nes (not elsewhere specified) followed by plates, sheet and films are imported the most among all products. The significant import quantity of plates, sheet and film can be linked back to the highest supply of these materials in Australian economy, that is inferred while analyzing supply and usage scenario. Also, basic polymers such as PVC (Poly Vinyl chloride) and polystyrene are the least imported products.

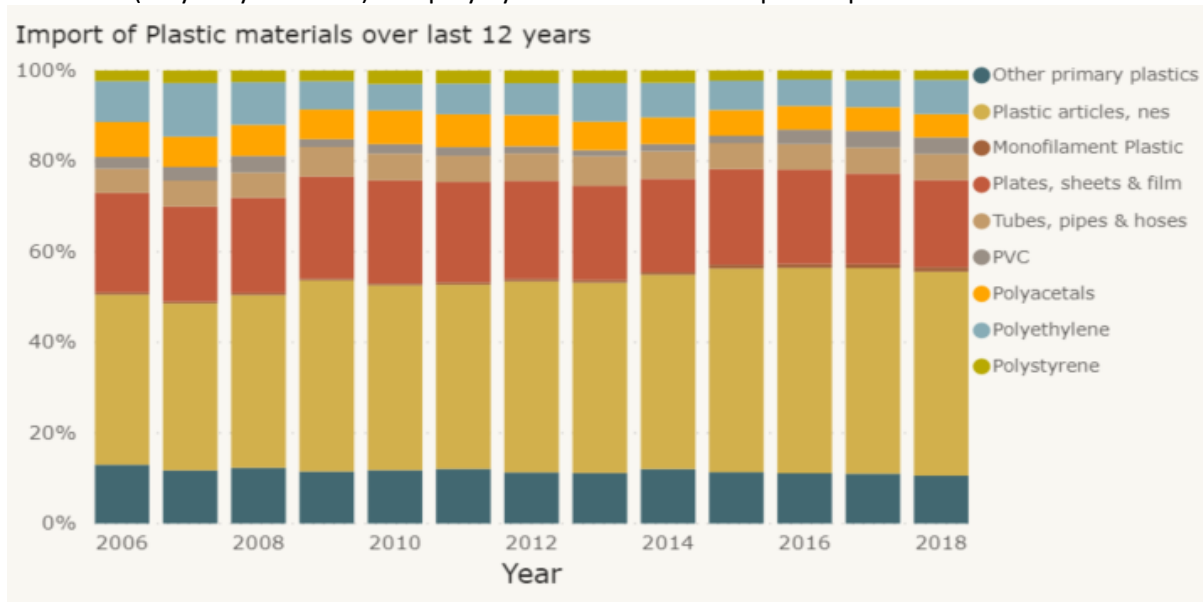


Figure 29 Plastic Material Import Trend

- Similarly, the export trend remains stationary across almost all products. Here, the plastic waste and scrap materials are appeared as oposed to import scneario. The slight decrease in the export of waste and scrap around year 2017 can be the result of changing policies by trade partners.

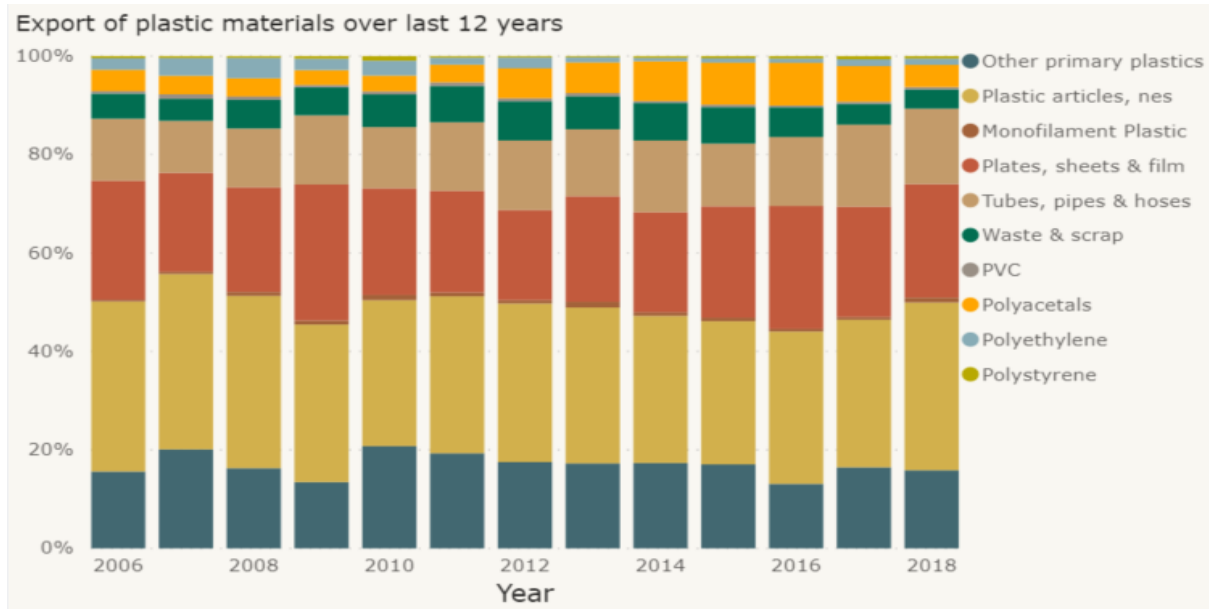


Figure 30 Plastic Material Export Trend

➤ Top Trading Partners (countries) of Australia:

Now, In the international trade of goods and services, Australia holds a vital role by trading with many countries from long time. Also, Plastic accounted for approx. 2.8% of Australian total import making it one of the top 10 trade items in 2018. Below is the list of top 5 trading partners from which Australia has imported and Exported the most plastic products by dollar value during 2018.

Country	% Import	Import (A\$000)	Contry	% Export	Export (A\$000)
China	58.49%	28,83,763.88	New Zealand	49.10%	2,97,905.65
United States	14.28%	7,04,150.53	China	14.99%	90,929.67
Thailand	10.37%	5,11,203.07	Vietnam	14.16%	85,924.03
Malaysia	9.10%	4,48,882.24	United States	12.01%	72,847.50
Germany	7.76%	3,82,657.14	Indonesia	9.75%	59,176.51

Figure 31 Top Trading Partners for Plastic Products

From above import table, it can be seen that china is the leading trade partner with almost 58% import of plastic products alone. Also, 15% of the total plastic products are exported to china. New Zealand is the major trade partner in terms of export, as 49% of the plastic products are exported from Australia.

Now, product-wise top 5 import and export trading countries can be explored. For instance, below snapshot of the dashboard shows top 5 countries accounted for import and export of plastic plates, sheets and film in Australian economy.

Visualisation of Plastic Data

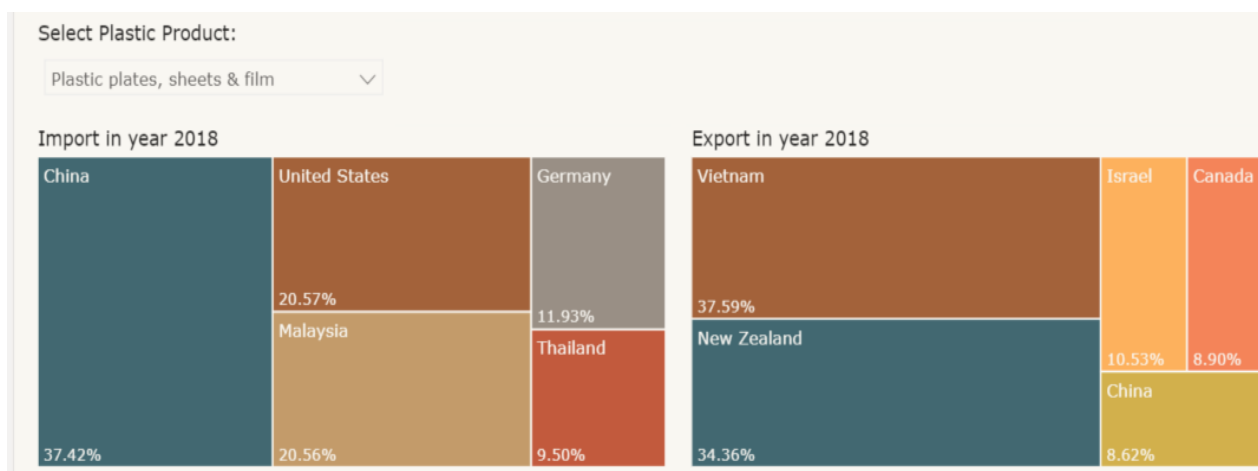


Figure 32 Plastic product wise top 5 Trading Partners

Conclusion

As plastic has become a global issue, there are multiple policies and projects coming into action to deal with the pressing global challenge. However, the analysis does not show any significant results of all these acts, policies, and actions. At present, usage of virgin plastic is still dominating, and recycled materials suffers from very less market demand due to its quality and usage limitations. There is limited infrastructure and technologies to deal with rapidly increasing plastic waste and most of it ends up in landfill followed by oceans. As the dependency on the plastic materials is notable, its products need to be handled well, particularly at the end of its service.

Reprocessing operations across any state makes a significant contribution to the economy by increasing employment and investment. Moreover, it also consumes less resources as compared to virgin plastic production and beneficial in terms of economy and environmental effects. Therefore, using reprocessed materials seems like an advantageous alternative. Some of the environmental benefits of using reprocessed materials over virgin material are; reduction in usage of natural resources, reduction in hazardous and unwanted gases (like greenhouse gases) from landfill and production, reduction in contamination of groundwater and soil resulted from landfill.

Our conscious ignorance towards environment has a devastating effect in long run. Hence, this report is prepared with the intention to cover all end to end lifecycle with maximum possible details with the data available. Industries, government bodies, researchers and any individual can access prepared interactive dashboards to take advantage of every minor details covered in this analysis.

Plastic type and industry-based analysis allows to derive plastic product specific operations to divide this huge task. Knowledge of industries supplying or using various plastic types facilitates to drive research in developing application specific alternative solution. For example, knowing the mapping of the highly used plastic polymer's applications in particular industry can better help stakeholders to develop solutions. From economical perspective, another significance of this study allows to focus on deriving plastic products which are being imported to or exported from foreign countries. Import, export, and trade balance scenario has details of such products which requires local production to improve the trade

balance in Australia. Overall, this study provides a pathway to develop worthwhile target programs for improvised plastic product management.

Discussion and Future Work

The dashboards developed in this study provide the overall analysis of plastic material life cycle from its supply in Australian Industries to its end of life fate. The Analysis of plastic supply and usage by Industries shows that Plastic is an integral material for all major industry divisions and subdivisions. The trade scenario also justifies its major contribution in Australian economy. This analysis can be used to identify the industry domain to focus upon, that supply and uses the most plastic products with very short life span and contribute the most in pollution. Also, from the comparison of plastic product supply and usage, the potential products that need to be replaced or reduced to overcome the issues imposed by plastic usage.

Also, the Waste supply, usage and treatment analysis depicts the industries that can use the plastic waste most and further innovative solutions can be designed to promote the usage of more plastic waste. Also, the gap in the good treatment practices (that are recycling and energy recovery) and landfill is highlighted to present the current scenario and scope of improvement. Australia is one of the top 10 countries generating the most plastic waste and it is essential to address the waste management issues across the country. The state-wise scenario enables comparison among all Australian states and depict the states following good management practices as compared to others. Australia still has the scope of improvement and research in energy recovery from plastic waste as currently only negligible amount of activities are being done in this direction.

Moreover, while looking at the packaging scenario, very less recovery rate for each type of plastic packaging is inferred. While comparing the scenario of the packaging material handling by other countries, more than half of the European countries have achieved plastic packaging recycling rate above 40%. Also, few countries such as Switzerland, Austria, and Netherlands have managed to use their post-consumer plastic waste for recycling and energy recovery completely without sending anything to landfill [10]. Whereas Australia has managed to achieve 16% of recovery rate for total plastic packaging materials till 2017-18. Australia can work in direction to achieve a higher recovery rate for plastic products to reach the circular economy goals.

To extend this analysis, some of the untouched domains related to plastic life cycle like Kerbside waste management and Marine Litter across Australia can be analyzed in detail. Also, more consistent and domain specific data can be systematically collected or gathered via efficient methods can enrich the analysis.

Literature Review

Many resources outlining the analysis of waste and more specific analysis of plastic data are reviewed to finalize the scope of the project.

[6] outlines the total waste generated and managed by the waste collection and resource recovery sector in Australia. This study provides analysis of plastic waste from its collection to end of life fate.

The aim of [8] is to explore plastic consumption and recovery either locally or overseas. It shows in-depth analysis of waste streams, sorting, and processing of waste and other key flows along with recycled product markets analysis. The report about European plastic Industry [10] outlines the plastic consumption, demand, waste management and trade scenario providing important facts about the plastic industry contribution to European economic growth throughout the life cycle of plastic materials.

The study related to Australian packaging consumption and recovery is published by Australian Packaging Covenant Organization in [5]. It discusses Australia's 2025 National Packaging Targets providing a pathway to new sustainable solutions to deal with present issues imposed by packaging waste materials.

Self-Evaluation, Learning & Challenges

This project is implemented by a group of two. The responsibilities are equally divided among two of us as described below:

Table 2 Task Division among Team Members

Task	Implemented by
<ul style="list-style-type: none">- Initial Understanding and exploring project definition and scope- Learn PowerBI to align with Industry partner requirement of implementation tool- Finalize the scope and project plan- Brainstorming for dashboard designs- Literature Review- Report Writing	Both
Data Exploration for first dashboard of plastic Supply and Usage	Vishwa Gandhi
Implementation of Plastic Supply and Usage dashboard in Power BI	Salina Bharthu
Data Acquisition, exploration and implementation for waste supply and usage by Industries dashboard	Vishwa Gandhi
Data Acquisition, exploration and implementation for waste management and recovery analysis for all Australian state dashboard	Salina Bharthu

Data acquisition for trade scenario and packaging dashboard	Salina Bharthu
Implementation of Packaging dashboard	Vishwa Gandhi
Implementation of country wise trade scenario dashboard	Both

Major learnings from the challenges are:

- Learnt to work in Agile manner
- Industry communication and collaboration
- Data Visualization tools & techniques
- Teamwork and presentation skills
- Developed skills to determine scope of the work and self-paced learning

Project Implementation Challenges:

- Learning PowerBI dashboard from the scratch to align the implementation tool requirement by Industry partner
- While deciding the scope of the project, it was very challenging to finalize the impactful domains to explore related to plastic data analysis due to very less and inconsistent open data availability
- Very limited plastic data available to provide end to end plastic life cycle analysis
- Data accumulated from different sources with high inconsistencies needed to be refined and put together

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