

# Visualising Macao's Tourism

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**Abstract** — Macao's tourism industry has always been one of the most important industries driving economic progress. In 2015, the Macao Government Tourism Office (MGTO) initiated the Macao Tourism Industry Development Master Plan project to build and manage its tourism economy, as well as to provide a blueprint for the future development of Macao's tourism industry over the next 15 years. This research project aims to improve and enhance the current efforts by aiding policymakers in recognizing visitor patterns. Using visualisation tools, policymakers can make use of the interactive visualisation to gather insights and better understand visitors' arrival patterns, hotel preferences, spending patterns and trends on Macao's gaming industry. To achieve this, extensive data exploration, data cleaning, planning, storyboarding and development of the visualisation is performed. Key components of the visualisation include a bar chart, line chart, stacked chart, combination chart, heatmap, and radar chart. Some key insights that policymakers can derive from the visualisation are how the visitor's arrival to Macao can affect spending, hotel occupancy rate and the number of hotels in Macao, allowing for better analysis and decision making to stimulate tourism growth.

*Index Terms* — Macao, Tourism, Visitors, Arrivals

## I. INTRODUCTION

The tourism industry which has been the pillar industry of Macao – reports around 35 million visitors in 2018 and tourism revenues in Macao reached an all-time high of 18,352 MOP Million in the third quarter in 2018. The MGTO focuses on elevating the recognition of Macao as a tourist destination and attract more visitor arrivals. In its Five-Year Development Plan (2016 – 2020), MGTO stated its strategies and actions to stimulate tourism growth, which include diversifying tourism products and experiences, improve service quality and skills, rebrand Macao as a multi-day destination and expand high-value markets, optimise urban development model, manage Macao's tourism carrying capacity, utilise innovation technology, enhance tourism industry cooperation and enhance Macao's position as a core tourism city in the regional and international tourism community. In the event where tourism is developing slower than projection, MGTO has planned to impose more aggressive marketing campaigns, exploration of new potential markets, expedite product diversification and development, optimising tourism facilities and infrastructures, and the expansion of regional and international cooperation. To enhance its current strategies, greater exploration of Macao's tourist data such as yearly visitor arrivals, visitor spending patterns, hotel occupancy rate visitor's purpose of visit and the gaming industry is performed to better understand the tourism industry in Macao. The key interest of this research is to uncover the relationships between visitor arrivals and visitor spending, hotel occupancy rate, number of hotels and gaming gross revenue. This allows policymakers to uncover and utilise trends and patterns for more informed decision

making and further boost the economy by optimising marketing campaigns and imports.

Comprising of nine sections, this paper documents the research and development efforts taken to design and implement the data visualisation application that helps the MGTO to better understand their tourism industry through visuals.

Overview of the research paper is as follows:

Section I introduces the project and Macao's tourism industry. Section II reveals the motivation for the project and the objectives to satisfy the needs of the MGTO. Section III covers the background research of related works by government tourism agencies globally, where it provided us with design inspiration and highlight areas of improvement that can be incorporated into the design of the visualisation application. Section IV describes the visualisation approach of the project. Section V elaborates on the initial phase of the project that consists of data collection, exploration and preparation. Section VI explains the design considerations of the project. Section VII brings users through a comprehensive visualisation application. Section VIII showcases the key findings and insights of the project. Section IX concludes this paper with recommendations to MGTO and how they can make use of the insights gathered from the visualisation to improve the tourism industry in Macao.

## II. MOTIVATION & OBJECTIVES

The main motivation is to address the lack of a convenient and comprehensive platform to study the correlation and trends amidst Macao's most important industry towards their financial growth. The current visualisation tool employed by MGTO is inadequate and it is difficult to visualise trends and

uncover patterns for the tourism industry. The MGTO only provides market reports and basic infographics on tourist arrivals and hotel statistics. Furthermore, the MGTO does not have a proper visualisation for its gaming industry, which is a huge component of the tourism industry in Macao.

The interactive visualisation application would enable the MGTO to better analyse Macao's tourism industry. With the visualisation, we aim to identify the relation between the tourism industry, and its two biggest components: hospitality and gaming industry, as well as to uncover trends and patterns for MGTO to utilise to further boost their economy by optimising marketing campaigns.

This project aims to provide insights into the following:

1. Gain insights on the monthly/yearly visitor arrivals to Macao over the years
2. Identify tourist preference for hotels and hotel's occupancy rate
3. Breakdown of tourists' expenditure to find out which country is spending the most and which area they are spending the most on (e.g. Shopping, F&B)
4. Gain insights on Macao's gaming industry and which game contributes most to the gaming industry

### III. RELATED WORKS

Government tourism agencies have adopted visualisation tools to visualise numeric and statistical data. Some notable visualisations are shown below.

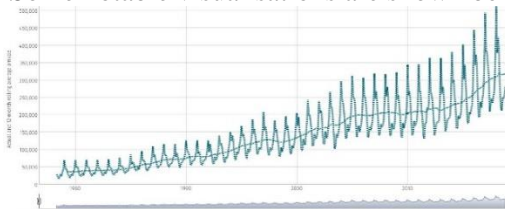


Figure 1: Yearly visitor arrival<sup>1</sup>

The line chart allows users to determine how many international tourists are coming into Macao every year. However, this visualisation is only limited to displaying the overall incoming tourist into Macao and users are unable to visualise the incoming number of tourists from each country individually. To overcome this drawback, we will add filters on the dashboard to allow users to control what they want to visualise on the chart.

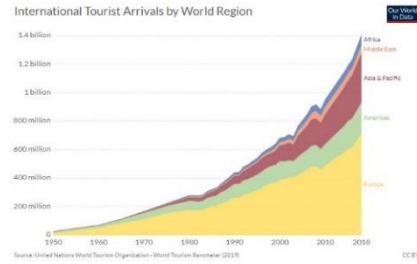


Figure 2: International Tourist Arrivals by Region<sup>2</sup>

An area chart is an effective way of displaying the total international tourist arrivals by region. The areas depicted by different colours allows users to see the breakdown of tourist arrivals for each region. This allows users to get a rough gauge on the number of tourists just by looking at the area.

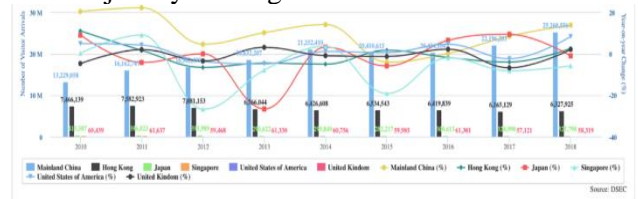


Figure 3: Number of Visitor Arrivals (by counties)<sup>3</sup>

The combination graph shows the comparison of tourist arrivals from China/Hong Kong and international visitor arrival from different countries. However, this visualisation may seem confusing as there are too many lines displayed on the graph. One way to improve the visualisation design is to display 2 lines that enables the comparison of visitor arrivals between China/Hong Kong and international visitors.

Overall, these visualisations are well-designed, and it allows the government tourism agencies to better understand their country's tourism industry and how they can better formulate their marketing strategies. Furthermore, conducting background research serves as a great approach for us to better understand the topic of our research that will help us during the planning phase when designing the storyboard. After analysing the visualisations and identifying the drawbacks of each design, we will tap on the positives and allow users to analyse and gather more comprehensive insights with the use of filters.

### IV. VISUALISATION APPROACH

The project consists of 4 main phases. Phase 1 is the idea generation phase where we create, develop and communicate abstract, concrete or visual ideas. Phase 2 serves as the foundation of the project and it consists of tasks such as data collection, exploring, cleaning and preparing. We then proceed on to phase 3 where we start to plan, design and create the

<sup>1</sup> [https://mbienz.shinyapps.io/tourism\\_dashboard\\_prod//center](https://mbienz.shinyapps.io/tourism_dashboard_prod//center)

<sup>2</sup> <https://ourworldindata.org/tourism>

<sup>3</sup> <https://dataplus.macaotourism.gov.mo/>

storyboard for the visualisation application. When the design is finalized, we moved on to phase 4 where the team starts to develop the visualisation application.

## V. DATA COLLECTION, EXPLORATION AND PREPARATION

The comprehensive repository of Macao tourism data used in this project was gathered from the MGTO website and the CEIC database provided by economists, analysts, investors, corporations, and universities across the globe. For this project, the focused time range is from 2011 – 2018. The rationale for choosing this time range was because it serves as a substantial range to identify relevant trends. Analysing and visualising 8 years of data would enable the government tourism agencies to get a better understanding of Macao’s tourism industry and it will allow them to make accurate predictions in the long run. Furthermore, when more data is taken into consideration, there will be more reliability credibility in the results of the key findings and insights derived from the visualisation application.

After the data was collected and finalized, we conduct data exploration using R to understand the dataset and identify characteristics of the dataset. Moreover, to ensure that the dataset collected is not flawed, we carried out a concise test to validate the accuracy of the dataset. One of the tests that we did was to check the visitor arrivals figure. Based on the official Macao tourism report, it was reported that the visitor arrivals to Macao in 2018 is 35 million. Hence, we used R to cross-check this figure with the visitor arrivals data that we have collected. The result of this test has proven that the figure is aligned, and the dataset is relevant and accurate to be used for analysis.

Data preparation is another important step of the project and it involves cleaning and transforming the data for processing and analysis. Tasks performed in this phase include:

1. Remove irrelevant columns and rows (e.g. discontinued data)
2. Insert/change column names
3. Pivot the date data from columns to year, month and quarter rows
4. Standardising the format of the data across all datasets

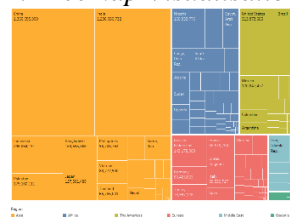
After the data cleaning process, the datasets are exported into Comma-Separated Value (CSV) files for portability and ease of loading for the web-based visualisation application.

## VI. DESIGN CONSIDERATIONS

In phase 2, the team planned, designed and created the storyboard. We conducted intensive research on visualisation ideas, design, and technologies to gain inspiration for our visualisation application. Important considerations taken in this phase were clarity of visualisation, aesthetics – for creating memorable and engaging visualisation that is an integral part of generating and communicating insights. The storyboarding process began with the team sketching the charts on the whiteboard for brainstorming purposes and to review all the proposed designs for the visualisation application. After all the designs were laid out, the team assessed and curated every chart and pieced the charts that are related to tell a story.

After the completion of the storyboard, we sought advice and opinions from Prof. Kam on the design of the storyboard and improve the design based on his feedback. This is an iterative process of how we derived the final storyboard. We are intending to use the following visualisations in our final visualisation application as it met all our considerations and it has all the positive attributes of a visualisation.

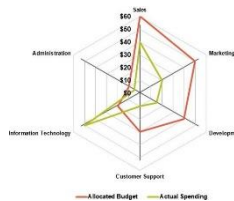
### 1. Treemap Visualisation<sup>4</sup>



The treemap visualisation enabled the team to visualise the number of tourists coming from different regions and countries and the total spending by different

visitors going into Macao. The use of this visualisation allows the team to easily derive and identify the top 3 visiting countries just by looking at the proportion of the squares.

### 2. Radar Chart Visualisation<sup>5</sup>

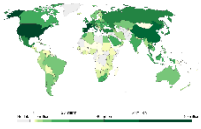


The radar chart does not only provide insightful information, but it is also aesthetically pleasing. It is used to display the breakdown of tourist spending into different categories (e.g. shopping, F&B, etc) and it allows for multiple overlaying of visitor spending from different countries. This enabled the team to easily identify and compare countries with the highest spending for each category. However, having too many overlays on a chart may cause the chart to be complicated and tedious to visualise and thus, lose its value.

<sup>4</sup> <https://www.dataplusscience.com/UsingTreemaps.html>

<sup>5</sup> <https://www.slideteam.net/spider-chart-allocated-budget-and-actual-spending.html>

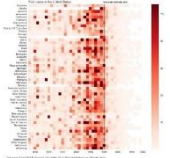
### 3. Map visualisation<sup>6</sup>



The world map visualisation allows the team to visualise geographical location information of where visitors are coming from.

We can use the map visualisation, together with the colours, legend, and scale to represent the spending of each country or the number of visitors coming to Macao (the darker the colour → the higher the number of visitors).

### 4. Heatmap visualisation<sup>7</sup>



The heatmap is an effective visualisation that helped the team to better visualise the volume of events and it assists in directing user's attention towards areas on the visualisation that matter most.

This would be used to identify tourist preference for the different hotels (e.g. 5-star, 4-star, etc) and it will allow us to quickly understand tourists' behaviours and patterns.

## VII. VISUALISATION APPLICATION WALKTHROUGH

Phase 4 of our project involves developing the visualisation application. The pages and graphs are put together using R Shiny. The detailed walk through of each page of our visualisation application can be found below.

At the top of the visualisation application is a navigation bar that enables users to explore the different components of our application. To enhance the user experience of our visualisation application, we included a filter pane on the left of every page to enable users to customise the visualisation and analyse specific area of interests. Filters available on the dashboard includes method of travel, region, month, year, accommodation type and expenses.

### A. View of Home Screen



Figure 4: View of Home Screen in application

The home screen in figure 4 displays the problem & motivation and the objectives of our project. Our visualisation application aims to meet those objectives and overcome the problems stated.

### B. View of Economic Contribution Screen



Figure 5: View of Economic Contribution Screen in application

The Economic Contribution screen as seen in Figure 5 consists of a combination and line chart to analyse the economic contribution of Macao.

1. The combination chart visualises Macao's GDP per Capita – MOP and tourist spending per capita from 2011 – 2018. This allows users to compare and analyse the growth and relationship between the two data across the years.

2. The line chart analyses the annual high-level contribution of tourism in terms of hotels, tourist spending, and visitor arrivals. It enables users to see the trend and identify which area is not doing well over the years.

### C. View of Visitor Arrivals Screen

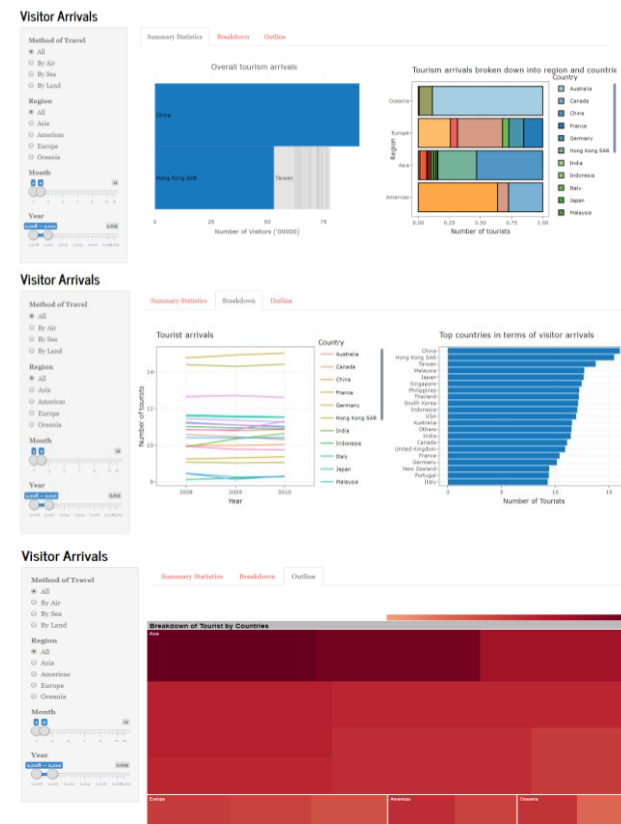


Figure 6: View of Visitor Arrivals Screen in application

<sup>6</sup> <https://ourworldindata.org/tourism>

<sup>7</sup> <https://www.kdnuggets.com/2016/03/4-lessons-brilliant-data-visualization.html>

This Visitor Arrivals screen consists of three tabs. The summary statistics tab shows the top 3 countries in terms of visitor arrivals and the number of visitors over a three-year period by region and country. The breakdown tab includes a line chart that provides the time series analysis of visitor arrivals per country. This allows for easy comparison to be made and it allows users to identify any fluctuation in visitor arrivals patterns. The bar chart visualises the breakdown of the number of visitors coming into Macao from each country. The outline tab consists of a treemap that shows the breakdown of tourist arrivals by region followed by a drilldown by countries.

#### D. View of Hotel Occupancy Rate Screen

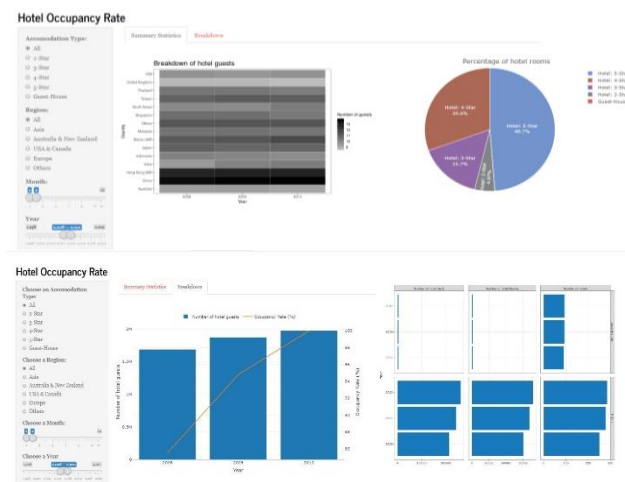


Figure 7: View of Hotel Occupancy Screen in application

The Hotel Occupancy Rate screen consists of two tabs. The summary statistics tab shows a heatmap and pie chart that visualise the occupancy rate of visitors from different countries and the occupancy rate for the different types of hotels (e.g. 5-star hotel). Users can mouseover the pie chart to see the actual figures and percentage. The breakdown tab includes a combination that visualise the relationship the number of hotel guest and the occupancy rate and a bar chart that shows a breakdown of the number of hotels, hotel rooms and beds across the years.

#### E. View of Gaming Industry Screen

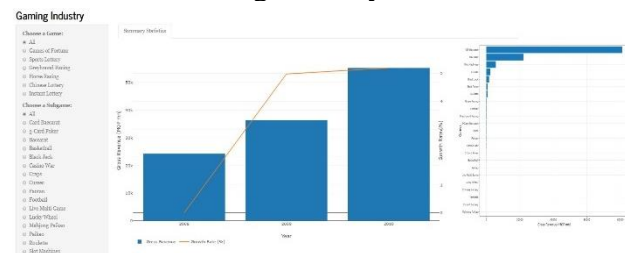


Figure 8: View of Macao's Gaming Screen in application

The Gaming Industry screen uses a combination chart to visualise the gross revenue and growth rate of Macao's gaming industry. Furthermore, with the use of a horizontal bar chart, users can easily determine the top 3 games played by tourist over a specific time.

#### F. View of Tourist Spending Screen

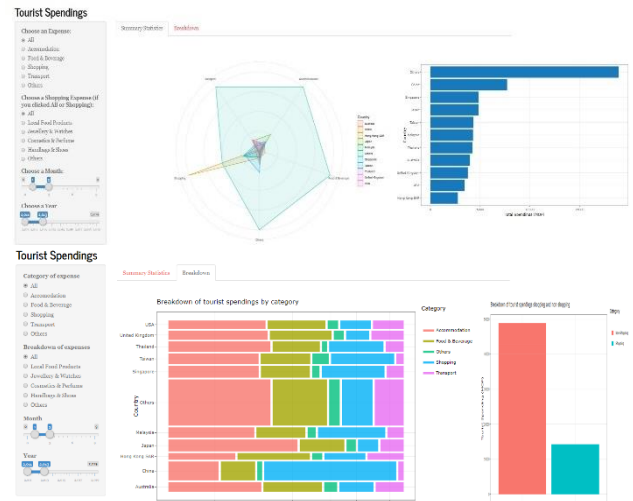


Figure 9: View of Tourist Spending Screen in application

The Tourist Spending screen has two tabs. The summary statistics tab consists of a radar chart and horizontal bar chart to compare the yearly expenditure by country and the breakdown of their expenses in different categories (e.g. shopping). Users can also easily identify countries that are spending the most in Macao. The breakdown tab shows a stacked bar chart that visualise the proportion of spending of each country broken down into various expenses category. Moreover, the bar chart provides an analysis on tourist spending on shopping.

#### G. View of Comparison Screen

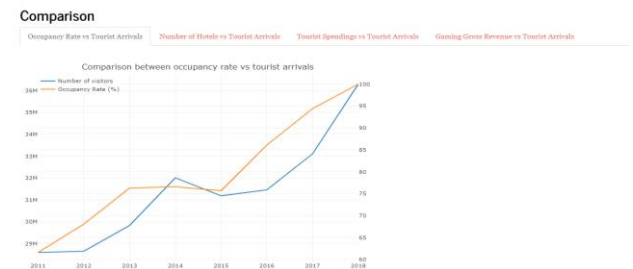


Figure 10: View of Comparison Screen in application

The Comparison screen consists of four tabs that allows users to compare and visualise the relationship between tourist arrivals and occupancy rate, number of hotels, tourist spending and gaming industry gross revenue.

## VIII. KEY FINDINGS AND INSIGHTS

The following key findings and insights were obtained in response to the defined research project objectives.

### A. Gain insights on the yearly visitor arrivals to Macao over the years

In the period of 2011 – 2018, the top 3 regions visiting Macao is Asia, Americas and Europe. Diving deeper into Asia, the top 3 countries visiting Macao is China, Hong Kong and Taiwan. This shows a stable trend and therefore, it is beneficial for the Macao government to continue placing marketing efforts to retain and attract tourist from these countries. To draw more visitor to Macao, the Macao government can also consider focusing on countries with the lowest number of visitors; namely Portugal, Italy and New Zealand. Macao government may want to find out why these countries are not coming into Macao and subsequently implement marketing efforts to draw people from those countries. This will increase the overall number of visitor arrivals travelling to Macao.

### B. Identify tourist preference for hotels and hotel's occupancy rate

Macao has mostly high-end 4star and 5-star hotels. This shows that there is a lack of budget hotels in Macao and thus, causing an imbalance in accommodation offerings. However, the imbalance does not affect the number of visitor arrivals to Macao. In the period of 2011 – 2018, there was an increase in visitor arrivals, causing the hotel occupancy rate to increase. This shows that there is a direct relationship between the visitor arrivals and the hotel occupancy rate.

The total number of hotel guests was consistently above 2 million each year (2011 – 2018) and in 2018, there was a significant increase in the number of hotel guests which amounted to 3.5 million, corresponding to an occupancy rate of 100%. Majority of hotels in Macao are occupied by visitors from China. As such, the Macao government can impose more discount packages for tourist coming from China to boost its hospitality industry. On another hand, we can see that tourist coming into Macao are not looking to stay in budget hotels but instead they prefer living in high-end hotels. Moreover, as the hotel occupancy rate increases, the number of hotels, hotel rooms and bed increase as well. This shows that the Macao government has done well in directing its resources to build more high-end hotels to cater to the needs of tourist.

### C. Breakdown of tourists' expenditure to find out which country is spending the most and which area they are spending the most on

Mainland Chinese visitors are the largest spenders with MOP 2,322 per capita spending in the period of 2011 – 2018 among all the top source markets. Spending of visitors from China, Singapore, Japan, Malaysia and Taiwan were above the average spending of all visitors. Hong Kong visitor's spending was the lowest among the top source markets. Spending of visitors from Taiwan has decrease year by year since 2016.

Visitors are spending the most areas that are non-shopping related, specifically on accommodation. Therefore, Macao government should divert more attention, time and resources to its hospitality industry as tourist are willing to spend more on accommodation when visiting Macao and this could help to increase the visitor arrivals to Macao.

### D. Gain insights on Macao's gaming industry and which game contributes most to the gaming industry

Macao holds a leading position in the global gaming market. In the period of 2011 – 2018, the top 3 most played games in Macao's casino is VIP Baccarat, Baccarat and Slot Machines. Therefore, to attract more tourist to its casino, the Macao government can use/showcase these games in their marketing campaigns. However, over the years, the gaming industry is not doing very well. The gaming revenue of Macao started to drop in 2014 and had a dramatic dip in 2015. Despite the drop, Macao managed to survive the plunge in its revenue and its revenue has been increasing steadily since then. But, its growth rate is unstable, and it dropped from 19.8% to 8.8% in 2018. Hence, it is important that the Macao government should not rely too much on its gaming industry and it is ideal that they should divert some resources from the gaming industry to other industries in order to retain and attract more tourist arrivals.

## IX. CONCLUSION

This research project has uncovered many insights on Macao's tourism that can help Macao's government to better understand the industry. By analysing its tourism data over the years, it enables them to make more informed decisions and formulate better goals and strategies that can help to increase the number of visitor arrivals to Macao and at the same time boost its economy. This is in line with the Macao SAR's vision to become the "World Centre of Tourism and Leisure".