VISITORS OF SINGAPORE

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***Abstract*—Tourism has always been a sector of large importance to Singapore's economy. The Singapore Tourism Board (STB) has outlined a strategy to grow Singapore's tourism industry through identifying growth potential for current and future markets. This research project attempts to enhance current efforts by aiding policymakers with recognizing visitor patterns. Using an exploratory visualization tool, this project provides such policymakers with an added capability of visually discovering noteworthy patterns in their visitor data. This improves the formulation of visitor market segmentation strategies and engenders better understanding of the relationship between visitor numbers, proportion of visitors to Singapore against the total outgoing populace, and their spending pattern. To achieve this, extensive data exploration, planning, prototyping, storyboarding and development of the visualization is done. Key components of the visualization include a geomap, bar and line graphs, and radar chart. A key insight that STB can derive through the exploratory visualization tool is how the proportion of visitors to Singapore affects their expenditure pattern, allowing for better analysis of visitor profiles for market segmentation efforts.**

***Index Terms*—Tourism, Visitors, Singapore, Expenditure**

I. Introduction

THE tourism industry is of great economic important to Singapore – amounting to SGD17.1bn, accounting for 4.3% of Singapore's total GDP in 2016[1]. The Singapore Tourism Board (STB), under the portfolio of the Ministry of Trade and Industry, thus focuses efforts towards stimulating growth in Singapore's tourism industry. In its 2016 Marketing Report, STB stated its intention to grow Singapore's tourism industry through market segmentation of the focused Asian market[2]. To augment this strategy, greater discovery of Singapore tourist data in the form of yearly visitor numbers, the proportion of visitors to Singapore against the total outgoing populace, and their expenditure pattern is conducted to understand the profile of visitors into Singapore. The intrinsic relationship between visitor numbers, their country of origin and expenditure are of interest to this research. The understanding of such relationships would facilitate better analysis of the visitor profiles, allowing for more informed decision making by STB in its market segmentation efforts.

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Comprising of ten main sections, this paper documents the research and development efforts taken to design and implement a web-based data visualization application that aids STB with its understanding of visitor profiles and their expenditure patterns. Section I introduces the project and its industry relevance. Section II then reviews the motivation for the research project, along with the project objectives crafted to meet the needs of STB. Section III covers the background research of related works by government tourism agencies, drawing both inspiration and avenues of improvement for incorporation in the developed visualization tool. Section IV elaborates on the approach and methodology of the research project. Section V describes the iterative process and hypothesis testing involved in collating, exploring and preparing the data for visualization. Section VI explains the design considerations during the development of the visualization. Section VII walks through the completed visualization tool. Section VIII showcases the key findings and insights of the research project. Section IX concludes this paper with recommendations to STB and possible future extensions to the research.

II. Motivation & Objectives

This research is motivated by the lack of analysis done on the relationship between the proportion of visitors to Singapore and their expenditure pattern. A web-based data visualization tool is selected as the means to visualize these datasets due to its ability to facilitate data discovery and the highly accessible nature of a web application. This is done with the aim of assisting STB with visually discovering meaningful patterns that provide better understanding of visitor profiles for more informed market segmentation efforts. This data visualization tool accounts for both the overarching trends across all top 13 visitor countries and the specific nuances for each country.

This project aims to provide insights into the following:

1. Countries that are sending the most tourists to Singapore
2. Proportion of tourists coming to Singapore against the total outbound residents of the country
3. Comparison of their expenditure and income patterns
4. Breakdown of tourists' expenditures to find out which industries are they spending most on

[1] Turner, R. & Freiermuth, E. (2017). Econmic Impact 2017 Singapore. *World Travel & Tourism Council.* https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2017/singapore2017.pdf

[2] STB Corporate Communications. (2016). Marketing Strategy: Of Stories, Fans and Channels. *Singapore Tourism Board.* https://www.stb.gov.sg/news-and-publications/publications/Documents/Marketing_Strategy-Of_Stories_Fans_and_Channels.pdf

III. Related Works

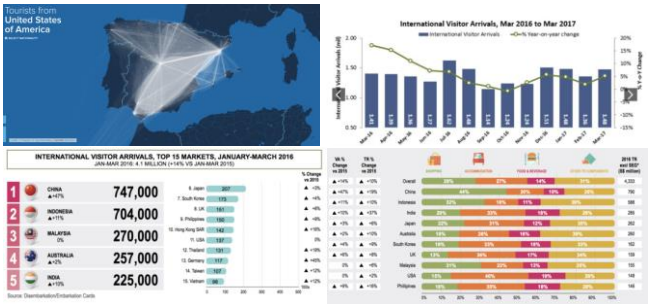


Fig 1. (clockwise from top left) Geographical map of tourist arrivals, time-series line chart with bar chart, infographic on Singapore's Top 15 visitor countries, stacked horizontal bar charts on breakdown of visitor expenditure items

The existing visualization tools employed by government tourism agencies are used to visualize numeric and statistical data. Some noteworthy visualizations are reflected in Fig. 1.

The use of a geographical map along with line thickness to represent the relative number of tourists compared to other countries enable viewers to have a quick and clear overview. The dual axis graph depicting both time-series of percentage change and absolute visitor numbers provides a broad overview of the overall trend in relation to the total number of visitors. The infographic used allows for quick data comparison between countries, with a depiction on whether the number of visitors have increased or decreased along with the percentage change. The stacked horizontal bar charts effectively display the expenditures of visitors by country, presenting both the expenditure breakdown within the country and comparison against other countries. The combined use of these four visualizations are useful in displaying the data of visitor arrivals and expenditures. Analysts can spot trends and make comparisons easily, which greatly aids with their utility.

Overall, these visualizations are well designed, which serve to aid with hypothesis testing and validation that government tourism agencies engage in when formulating marketing strategies. Yet, this neglects the use of visualizations for data discovery, where patterns in the data themselves can be revealed. As such, this research project attempts to augment current efforts by focusing on the relationship between visitor numbers, proportion of visitors to Singapore against the total outgoing populace, and their spending pattern. This improves the formulation of visitor market segmentation strategies by identifying key traits such as market saturation over time.

IV. Visualization Approach

To develop a visualization tool that can help analysts with understanding the interwoven relationship between tourist numbers and expenditure pattern, three main project phases were conducted. These phases are (1) collating, exploring, cleaning and preparing the data, (2) planning, prototyping and storyboarding the visualization tool, and (3) developing the visualization tool. An iterative approach was chosen due to the shortened and more frequent feedback process, thereby maximizing learning[3]. Phase 1 serves as the foundation of the research project, encompassing two iterations. Phase 2 was conducted over one iteration, and Phase 3 spanned two iterations. Section IV elaborates on the data collation, exploration and preparation methodology, while Section V explains the design considerations in the planning, prototyping and storyboarding of the visualization tool.

V. Data Collation, Exploration & Preparation

The research project began with ideation on determining meaningful data to be visualized to aid STB with their marketing efforts. The definition of *International Visitor Arrivals* was also clarified, which refers to travelers taking a trip to Singapore whose length of stay is less than a year, excluding (a) all Malaysian citizens arriving by land; (b) returning Singapore citizens, permanent residents and pass holders; (c) non-resident air and sea crew (except for sea crew flying in to join a ship); and (d) air transit and transfer passengers[4].

The dataset selection process evaluated the dataset's relevance in studying the relationship between visitor numbers and their spending pattern. The CEIC Database provided by Euromoney Institutional Investor PLC provides a comprehensive repository of data for visitors to Singapore between 1976-2017. For the purposes of this research project, the focused range was decided as 2010-2015. The rationale for the selected range is due to the relevance of the closest five-year interval to the Singapore Tourism Board's 2016 Marketing Report, that highlights the Top 15 visitor countries. Analyzing data dated further back do not provide strong relevance to the analyst, hence creating the impetus for narrowing the date range. In addition, there are data and technical limitations in the datasets for 2016 and 2017, hence their omission in this visualization tool.

In Phase 1 of the research project, project objectives were determined to guide the formulation of hypotheses for testing and validation. To avoid bias in the data collection process, all data was collated and thoroughly explored before determining its relevance. Aiding the data discovery process was the use of Tableau to visualize potential relationships between different sets of data. This allowed for rapid prototyping and thereby validating hypotheses derived, maximizing learning for the team. Two iterations of data gathering and discovery were conducted, along with weekly reviews with Professor Kam Tin Seong, detailed in the subsections below.

A. Iteration 1 – Proportion of visitors to Singapore against the total outgoing populace

Iteration 1 worked with the hypothesis that the proportion of visitors to Singapore against the total outgoing populace from the same country would reflect the country's peoples interest in visiting Singapore. This would then aid with profiling the visitors for STB's marketing efforts. This hypothesis works on

[3] Oppermann, R. & Thomas, C. G. (1999). Learning and Problem Solving as an Iterative Process. *German National Research Center for Information Technology*. http://ui4all.ics.forth.gr/UI4ALL-95/oppermann.pdf

[4] Singapore Tourism Board. (2017). International Visitor Arrivals https://www.stb.gov.sg/statistics-and-market-insights/Pages/statistics-Visitor-Arrivals.aspx

the premise of the *network effect*, where an increased number of tourists improve the value of Singapore's tourism offerings[5], which the World Tourism Organization postulates as a key component of tourism marketing[6]. This hypothesis was tested through collecting the outbound tourism data of the Top 15 visitor countries to Singapore from the Yearbook of Tourism Statistics dataset from The World Bank, benchmarking this against the tourism numbers collected by STB and the tourist expenditure from the World Tourism Organization. This was done to determine if there was a correlation between the percentage of market captured by Singapore's tourism efforts and their total expenditure in Singapore. Through the data discovery process, there was indication of a correlation between the percentage of market captured and the total expenditure. However, through reviews with Professor Kam Tin Seong, it was established that the tourist expenditure data is too aggregated to form meaningful relationships between the data. Hence, this iteration was concluded with a plan to revise this hypothesis, changing the parameters of tourism expenditures.

B. Iteration 2 – Specific breakdown of tourist expenditures

Iteration 2 improved upon the findings of Iteration 1, through testing the hypothesis against the specific breakdown of tourist expenditure into various categories as captured by STB in its, namely *accommodation*, *food and beverage*, *shopping*, and *others*. *Others* was formulated to account for sectors not specifically under STB's or its parent Ministry of Trade and Industry's (MTI) purview – local transportation, business, medical and educational travelers. The use of this dataset provided more granularity with respect to identifying linkages between the percentage of market captured and the total expenditure of visitors from a country. The modeling and data discovery conducted during this iteration yielded significant insights into expenditure patterns of visitors, where both generalizations and anomalous skews were readily apparent. It was noted that majority of visitors to Singapore focused expenditures on the *others* category, which can be tied to Singapore's entrepot status, serving as a hub for key economic activities in the form of financial, medical and education services. This iteration allowed the team to validate its hypothesis that the proportion of visitors to Singapore against the total outgoing populace from the same country would reflect the country's peoples interest in visiting Singapore.

The data preparation process involved the cleaning and consolidation of disparate data sources, with judicious selection attributes based on their relevance to the research objectives. These comprised of (1) visitor arrivals per country in the Top 15 list (CEIC dataset), (2) total outbound populace from each country in the Top 15 list (CEIC dataset), (3) total visitor expenditure (STB dataset), and (4) specific breakdown of visitor expenditure (STB dataset). It was noticed that the Top 5 and Top 15 visitor countries accounted for over 60% and 80% of Singapore's total visitor numbers respectively. Concurrently, a limitation to the research project was discovered from the incomplete data available for the countries of Malaysia, Vietnam and Philippines. This issue was discussed within the team and subsequently surfaced to Professor Kam Tin Seong, who then advised on their omission. Another issue that surfaced was that the time period of STB's visitor expenditure data ranged only from 2013-2015, which served only as a subset of the visitor arrival data ranging from 2010-2015. However, the value of STB's detailed expenditure breakdown was deemed highly relevant and important to the purpose of the project, and was included in the visualization after confirmation with Professor Kam Tin Seong. These datasets were then exported into Comma-Separated Value (`csv`) files for portability and ease of loading for the web-based data visualization application. A cursory look at converting these `csv` files into JavaScript Object Notation (`json`) for transport and rendering data on the web was also conducted. The effectiveness of the data preparation was evaluated by loading the prepared data into Tableau, where the data format consistency, ease of understanding and visualization possibilities were assessed.

VI. Design Considerations

In Phase 2, the team researched on various visualization ideas, designs and technologies. Considerations in the form of clarity, aesthetics and technological implementation were made, with the team leveraging on its members' training in data visualization techniques and experience in web application development.

The storyboarding and prototyping process was conducted in an iterative fashion, beginning with whiteboarding for quick and visual understanding of the design, visualization and navigation. Various inspirations in the form of interactive charts were curated and assessed by the team, along with their storytelling potential. The nature of the data to be visualized served as a guiding principle behind the formulation of design ideas, enabling data discovery to be as seamless as possible.

On the technological aspect, a mix of modern web data visualization libraries and frameworks in the form of `d3.js`, `highcharts.js`, and `chart.js` was decided due to the features and functions that would be afforded to the development process. The JavaScript base for these technologies meant that the developed web data visualization application would be readily viewed on modern web browsers such as Chrome and Firefox without need for users to download any plugins. This would greatly aid analysts in using the visualization tool. The loading and transport of `csv` and `json` files worked asynchronously[7], allowing for highly responsive and interactive applications to be developed.

The following visualizations were adapted in the completed visualization tool due to their clarity and aesthetic attributes.

A. World Map Visualisation

The world map visualization enabled the team to display the geographical locations on a world map, showcasing the physical distance that visitors travel to get to Singapore. This visualization also shows the use

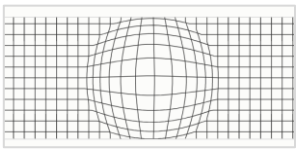
[5] Shapiro, C. & Varian, H. R. (1999). Information Rules. *Harvard Business School Press*. ISBN 0-87584-863-X

[6] World Trade Organisation. (1997). International Tourism: A Global Perspective. *WTO*. eISBN 978-92-844-0231-1

[7] JavaScript Async Calls https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/async_function

of scale and colors, to convey the number of visitors coming to Singapore from a given country, compared to the other top 13 countries.

B. *Fisheye Zoom*



The fisheye zoom allowed for better viewing of clustered data. Many of the top 13 visiting countries are in the ASEAN region, and due to their proximity to Singapore, many arrows and labels makes it difficult for a viewer to make active selections or comparisons. The fisheye zoom allows for finer mouse control by the user, without compromising on the overall view of the world map or distorting the sense of scope and scale.

C. *Radar Chart Visualization*

The radar chart facilitated an insightful expenditure distribution to be displayed, along with being aesthetically pleasing. The ability to overlay multiple such breakdowns helps with comparison via area and skew easily. It was learnt that too many overlays will make the radar chart too cluttered and lose its prime value in its pure simplicity.

VII. Data Visualization Tool Walkthrough

Phase 3 of the research project has resulted in the completion of the web-based data visualization application. The web pages are linked together using Twitter Bootstrap to create a seamless website, following the theme of travel and exploration. The detailed walkthrough of each page can be found below:

A. *View of Title Screen*

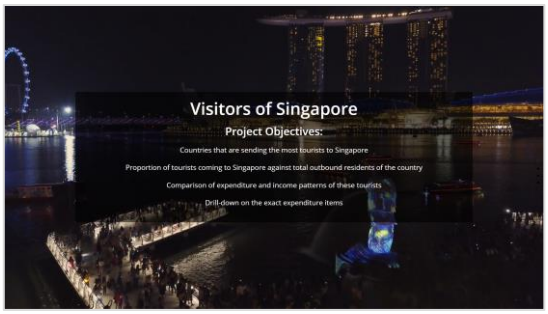


Fig 2. View of Title Screen in the Visualization Tool

The title screen as seen in Fig 2. indicates the objectives that the data visualization application seeks to accomplish on the topic of Visitors to Singapore.

1) *Video Background*

The use of a video background is meant to capture the different sights and places of interest in Singapore, playing to the theme of tourism. The application user is likened to that of a Singapore tourist, with the landing page akin to landing in Singapore. This invokes a sense of wonder and discovery, as a parallel to the data discovery process.

B. *View of Tourist Arrivals Screen*

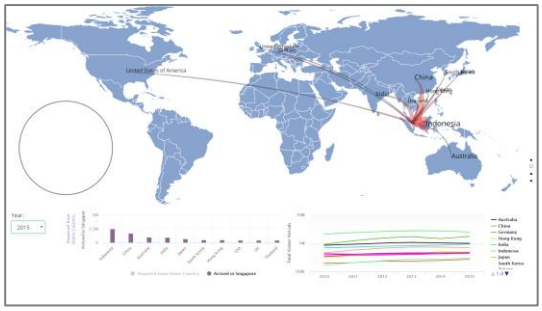


Fig 3. View of Tourist Arrival Screen in the Visualization Tool

The Visitor Arrivals screen as seen in Fig 3. consists of a geomap, line graph and bar chart to visualize different aspects of visitor arrivals, due to the multifaceted nature of the data. These visualizations are all linked by year, with the dropdown menu dictating the data that is presented on all charts to present a unified dashboard view of Visitor Arrivals.

1) *Geomap*

The geomap visualizes the travel pattern of visitors from Singapore's top 13 visitor countries between 2010-2016. The geomap allows the viewer to see the geographical locations of visiting countries on a scaled world map, depicting the number of visitors, the distance they travelled to Singapore, and how geographically close these countries are to each other.

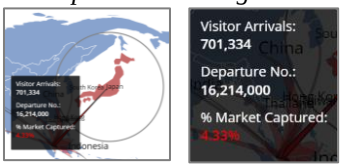
Sense of scope and scale

The geomap uses directed weighted arrows from visiting country to Singapore, with the weight being proportional to the absolute number of visitors visiting Singapore. Similarly, the font size of the country labels are weighted in proportion.

Fisheye zoom on mouse cursor for better navigation

Fisheye zoom allows for finer mouse control by the user, while maintaining the overall view of the world map, and the sense of scope and scale.

Tooltip when hovering over country label



Fisheye zoom allows for finer mouse control by the user, while maintaining the overall view of the world map, and the sense of scope and scale.

2) *Bar Chart*

The bar chart compares the number of Singapore visitors across the Top 13 visitor countries per year. These are ranked in descending order, showing the absolute number of visitors to Singapore per country. Following which, a toggle can be done to depict the absolute number of outbound visitors per country, allowing for a comparison by proportion of total outbound visitors arriving in Singapore. The bar chart also reveals the that the visitor arrivals follow a long-tail graph, suggesting a negatively skewed distribution, where the top 5 visitor arrival countries account for over 60% of all visitors to Singapore.

3) Line Graph

The line graph depicts a time-series of Singapore visitors from the top 13 visitor countries between 2010-2015. This allows for quick yet meaningful comparison of the visitor arrival trend over time.

Linkage with geomap for time-series of selected country

Upon hovering the mouse over a country label in the geomap, the line graph dynamically changes to show time-series of visitor arrival of a selected country

C. View of Tourist Expenditures Screen

Fig 4. View of Tourist Expenditures Screen in the Visualization Tool

The Visitor Expenditures screen consists of a radar chart and line graph, to compare the yearly expenditure by country and their detailed breakdown against the average. These visualizations are all linked by country and year, with the dropdown menu dictating the country and the pill buttons dictating the year to render data that is presented on all charts to present a unified dashboard view of Visitor Expenditures.

1) Radar Chart

The radar chart provides the breakdown of visitor expenditure per country, with a comparison against the average tourist expenditure. This allows for easy comparisons to be made, visualizing any skews in the data clearly.

Highlighting of area to aid comparison

Hovering the mouse cursor over the bounded area highlights the expenditure breakdown. The data can be toggled via the dropdown menu to select country to display and pill buttons for year.

2) Line Graph

The line graph provides the time series of visitor expenditure per country, with a comparison against the average tourist expenditure between the period of 2013-2015. This allows for easy comparisons to be made, visualizing any fluctuations in the expenditure pattern clearly.

D. View of Ending Screen

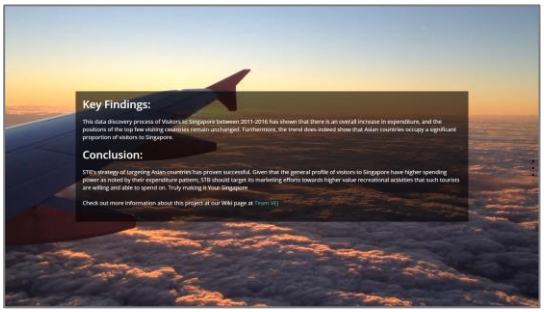


Fig 4. View of Ending Screen in the Visualization Tool

The ending screen as seen in Fig 4. displays the important insights gathered to meet the objectives of the Visitors to Singapore topic, along with a conclusion on what this data visualization application accomplishes and how might STB benefit from such findings.

1) Video Background

The use of the video background wraps up the theme of tourism, with a flying plane used to invoke a sense of closure and departure. The metaphor used for our application user is extended, gaining much from the experience and leaving the application in a similar fashion as leaving Singapore: fulfilled.

VIII. Key Findings & Insights

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

A. Objective #1: Countries that are sending the most tourists to Singapore

In the period of 2010-2015, the Top 5 visiting countries are consistently, in descending order: Indonesia, China, Australia, India and Japan. They also account for over 60% of all visitors to Singapore. With such a stable trend across these six sampled years, it would be beneficial for STB to continue focusing its marketing efforts on these countries. The current strategy of focusing on Asia looks to be promising for the coming years, coupled with the market segmentation of Tier 1 and Tier 2 countries. Considering Singapore's marketing approach of telling the Singapore story, it would also be useful to showcase the quintessential roles that these Top 5 visiting countries played in Singapore's progress.

The general trend that the visitor numbers to Singapore has been decreasing from 2013 to 2015 is a matter of concern. This trend is especially pronounced in Indonesia, China and Australia – three of Singapore's top visitor countries. A possible reason for this decrease can be derived by cross-referencing their expenditure patterns. The trend of China's tourist expenditure has been an extreme skew towards *shopping*, with shopping belts such as Orchard Road serving their interests well. The advent and permeance of e-commerce and online shopping would then be responsible for changing consumer behavior[8], where the thrill of the physical retail experience is trumped by the convenience and plethora of options afforded by online stores. Hence, China tourists are less incentivized to travel for shopping sprees. As for Indonesia and

[8] Mamaghani, F. (2009). Impact of E-commerce on Travel and Tourism: A Historical Analysis. *International Journal of Management, 26(3) pp. 365-375.*

Australia, their primary tourist expenditure has been on *others*, a need that could be similarly served by the urban development and affluence of these nations domestically. This is corroborated with the overall decrease in outbound tourist numbers from these Indonesia and Australia over the years. These explanations for the decline in visitor numbers boil down to the presence of substitutes – which STB can address through product/service differentiation tactics, ascribing a non-monetary value to Singapore's equivalent offerings for appeal[9].

B. Objective #2: Proportion of tourists coming to Singapore against the total outbound residents of the country

Asides from Indonesia with 34.14% of all outgoing visitors arriving in Singapore, the rest of the top 13 countries have <12% of their outgoing visitors arriving in Singapore. This can be attributed to the geographical distance between Singapore and these visiting nations, with a larger distance constituting a larger opportunity cost of time and money to travel to Singapore. The spending power of these nations also affect their proportion of visitors coming to Singapore, with the two largest proportions being Indonesia with 34.14% and Australia with 11.11%, both countries being within the 8h flight radius and with sizeable spending power. It is also noted that more affluent nations have a much number of total outbound residents, which lessens the opportunity cost of travelling. This low market capture of visitors is also attributed to the reason of travel to Singapore, as noted in the tourist expenditure breakdown. Key value-add industries in Singapore attract visitors, no matter their geographical distance with respect to Singapore. Given Singapore's tourism strategy and profile, it would be recommended to focus efforts on outreach to such countries, playing upon Singapore's reputation of interlacing tradition and modernity.

C. Objective #3: Comparison of their expenditure and income patterns

Studying the expenditure of tourists across the recorded time periods of 2013-2015 yields a worrying trend: on average, total overall expenditure has been on a downward trend, with SGD 972m in 2013, to SGD 949m in 2014, to SGD 874m in 2015. Majority of the sampled countries saw a drastic decrease in their expenditure between 2014 to 2015, with exceptions being Japan, Germany and United Kingdom which instead increased their expenditure. This can be attributed to both the affluence and geographical distance of these nations. Given that their visitors have to travel a further distance, the option of spending more in Singapore is less burdensome than neighboring countries who would have spent less on their transportation to Singapore. This results in STB needing to weigh the value between high volume/low expenditure and low volume/high expenditure visitors. Overall, it is apparent that Singapore's tourism economy is largely dependent on the world's economy, with fluctuations in the economic climate affecting the income levels of nations, thereby influencing their expenditure patterns in Singapore. STB should hence formulate its short-term tactics with other governmental agencies to be more abreast with economic patterns, improving agility when focusing on targeted marketing campaigns.

D. Objective #4: Breakdown of tourists' expenditures to find out which industries they are spending most on

On average, it is shown that majority of tourists' expenditure is in "*Others*", which constitutes expenditures on transportation (air, land, sea, transit), business travelers, medical and education. This is an interesting insight when contrasted against the visitor profiles and quantity of visitors per country, as it shows that Singapore attracts visitors due to its entrepot status and reputation as a financial, medical and educational hub. This is especially apparent in Singapore when juxtaposed to its ASEAN neighbors, which drives home the point that Singapore's tourism efforts should be targeted towards bolstering its key revenue-generating sectors and maintain its expertise in being a hub for such higher-order services. Another noteworthy finding is the relatively low expenditure made on shopping and F&B, save for Indonesia and China. This might appear contrary to typical tourism efforts that focus on culture, where F&B and shopping are considered Singapore's cultural legacies. Ultimately, the findings on expenditure, when contextualized with the visitor numbers and geographical distance of their origin country tells us that Singapore's heralded industries of finance, medical and education do play a large role in our tourism efforts, which STB should strongly account for in their visioning.

IX. Conclusion

This research project has revealed that the general Singapore visitor is one who is affluent, travelling for purposes outside the realm of leisure. This finding is discovered through the relationships noted between the visitor arrival numbers and their expenditure pattern. These visitors similarly do not account for majority of their country's total outbound populace, as reflected in Singapore's market capture statistic. Considering external competing forces such as e-commerce and domestic development, Singapore's targeted Tier 1 countries are indeed reaching a saturation point, with some crossing over to fatigue and resulting in a decrease in visitor arrivals and expenditure in Singapore. Despite this, a silver lining can be seen in Singapore's reputation as an entrepot – its reputation as a global financial, medical and educational hub are key drivers of Singapore's tourism sector. Hence, STB along with MTI should focus on complementing the ancillary services that support these key Singapore industries, weaving comfort and convenience into the visitor experience. This ties in with STB's overarching vision of *Your Singapore*, packaging a visit to Singapore as a trifecta of work, rest and recreation.

Acknowledgement

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[9] Krugman, P. (1980). Scale Economies, Product Differentiation, and the Pattern of Trade. *The American Economic Review 70(5) pp. 950-959.*