



Match and Play

CS5224 Semester 2 AY21/22

Group Project Final Report

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1. Executive Summary

PlayPal is a cloud-based web application targeting sports enthusiasts serving as a one-stop site to host, find and join leisure sports activities. Users can create events for others to join, or participate in existing events created by other users. The service recommends users a list of upcoming activities hosted by other users based on their preferences and interests.

At launch, it will be launched free and ad-supported so that PlayPal will be able to build up a substantial and loyal user base. With a larger user base, new features and monetization plans would be introduced, including: paid credits for boosting of events, paid listings for commercial event organizers, and revenue sharing of tickets sold. Economic considerations of the application will be expanded in the 'Economic Factors' section.

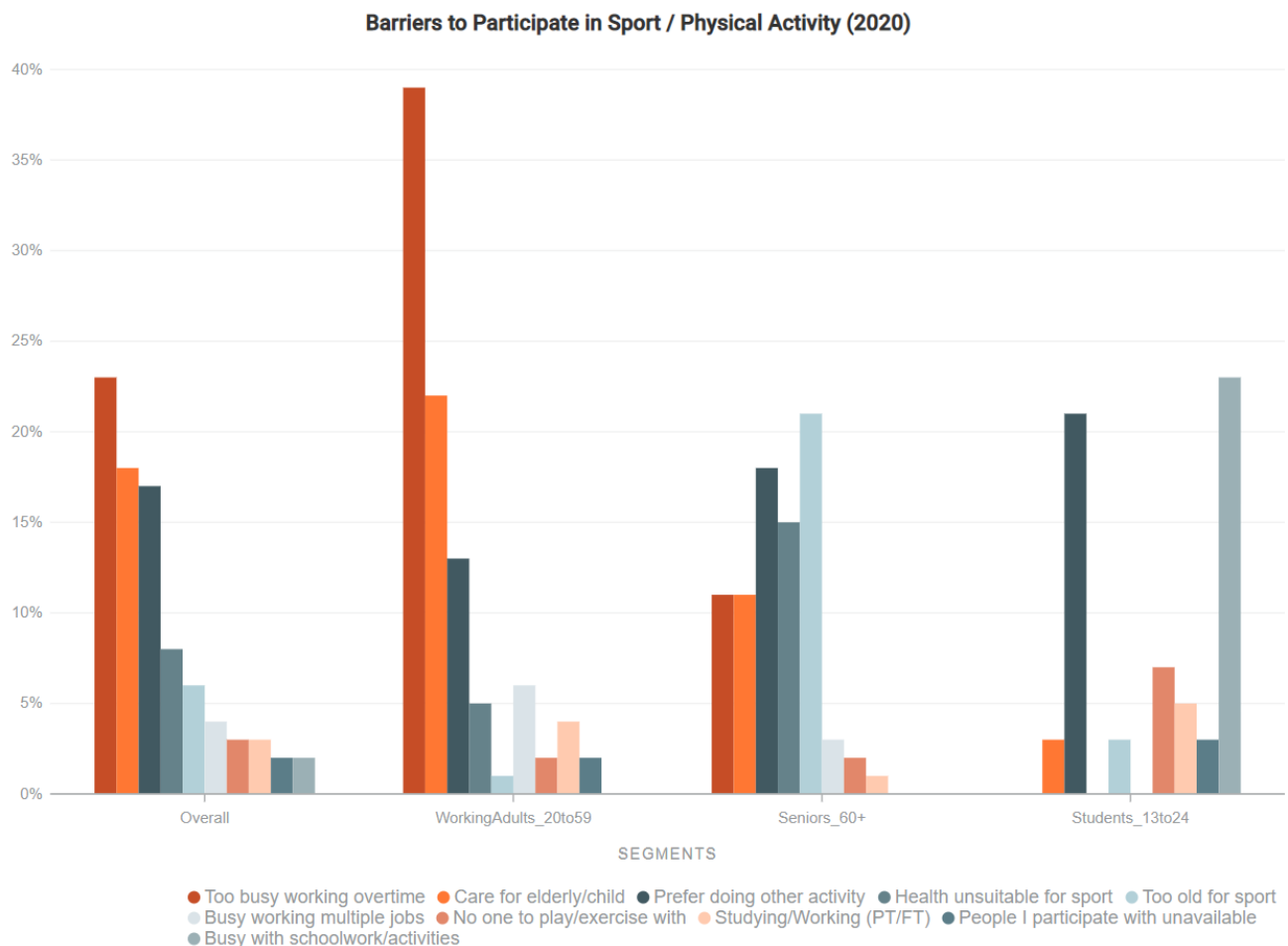
Responsive web design is used to ensure that the application works well on both the conventional website and mobile devices. The service is hosted primarily on AWS with MongoDB Atlas serving as the cloud database management system.

2. Business Case Identification

2.1 Problem Statement

Conventionally, for someone to arrange a sports activity, there is a need to perform outreach via word-of-mouth and invite acquaintances to the event. Sports lovers have limited access to information about the availability of other sports activities (e.g. location, date, and time) happening in their proximity which matches their availability and interests. For example, a soccer enthusiast would like to join a game of street soccer. He could either form a team with acquaintances or find an opponent team to play with via word-of-mouth.

We also noted that research from the National Sports Participation Survey (NSPS) on data.gov.sg site has shown that in the period 2020, the major barriers to participation in sports can be generally be categorized as follows, according to different age groups:



Source: DATA.GOV.SG

2.2 Purpose

Rather than relying on the off-chance of getting to know someone who has the same sports interests, with PlayPal having a centralized source of information, any user can host an activity or join other users in their activity. PlayPal strives to bring people together, connecting sports lovers and like-minded people who have the same interests, together. PlayPal can also recommend suitable activities to the user.

2.3 Target Users

The target users are categorized into two general groups:

- 1) Individuals
- 2) Commercial event organizers

At launch, only individuals are targeted to build the user base. Eventually, with a sufficiently sized user base, commercial event organizers will be onboarded to the service.

3. Business Model

3.1 Revenue Generation

At launch, PlayPal will be free and ad-supported to build the user base. Subsequently, users will have the ability to purchase credits to boost their listings. Eventually, with a sufficiently sized user base, commercial event organizers will be onboarded for commercial listings, and revenue sharing of tickets sold. For example, an organizer for a marathon can

list their event for a fee, the event will be promoted to users utilizing the built-in recommender engine.

3.2 Justification for Cloud Implementation

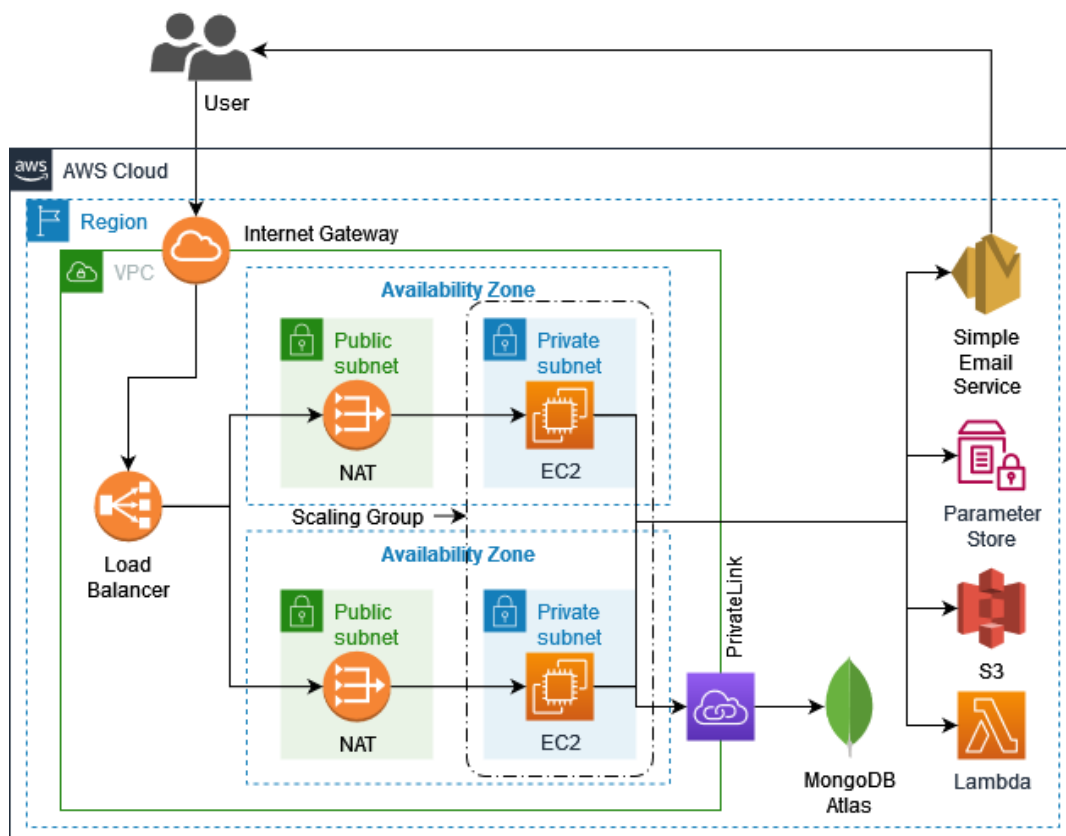
As a startup, the scale of the operation is likely to be in flux. Committing to on-premise resources to host the service would present substantial upfront startup costs. Moreover, it is difficult to size on-premise resource requirements at launch and scaling up or down operations based on variable user traffic will present challenges.

Utilizing a cloud service provider allows the service to manage costs in a more effective manner. Starting with computing resources with smaller capacity, and scaling up accordingly once demand increases.

4. Architecture and Implementation

4.1 Architecture

The architecture of the service is shown in the diagram that follows:



4.1 Web App Server

4.1.1 AWS EC2

PlayPal was developed using Node.js and is hosted on AWS EC2 instances in private subnets. Minimally, two instances of the service run behind a load balancer in separate Availability Zones, to ensure redundancy, availability, and fault tolerance. Should there be any substantial spike in demand, Auto Scaling Groups are configured and ready to scale out the service to meet demand. When exceptional demand subsides, the service will be scaled back to the desired capacity of two instances.

4.1.2 AWS Lambda

We utilize a Lambda function to perform the role of a recommender for logged-in users. For the application to work as intended, a few layers on AWS Lambda were added to the function so that the python code can work with libraries such as pandas.

4.1.3 AWS Systems Manager Parameter Store

Environment variables are stored in AWS Systems Manager Parameter Store.

4.2 Database & Object Storage

4.2.1 MongoDB Atlas

For the database, PlayPal utilizes MongoDB Atlas hosted in the same AWS region as the EC2 instances. MongoDB is a database management system with a NoSQL implementation. It was chosen as its flexible schema-less JSON-like document-oriented design enables greater flexibility compared to traditional relational database implementations (e.g. MySQL), providing our developers quicker turnaround time in implementing new features, especially in the earlier stages of our launch.

MongoDB Atlas can be hosted on AWS, Azure, or Google Cloud and was chosen due to its platform-agnostic nature. With hosting in AWS, MongoDB Atlas supports peering with the VPC hosting our EC2 instances through AWS PrivateLink (PrivateLink was not implemented in Proof of Concept due to costs), ensuring our EC2 instances have secure access to the data hosted in MongoDB Atlas. Additionally, MongoDB Atlas automatically creates replica sets to ensure high availability and automatic backups can be enabled with additional costs. It also provides the option of automatically scaling-up/down to and from higher-performing cluster tiers according to demand.

4.2.2 AWS S3

For object storage, such as user profile pictures, we will utilize AWS S3 in the same region as the EC2 instances. This allows enhanced and personalized user experience when using the site, as users are free to customize their profile however they like.

4.3 Utility Functions

4.3.1 AWS Simple Email Service

For service-to-user communication, we will utilize AWS Simple Email Service, for example, user registration emails. This will notify new users to verify various account details when they have signed up with PlayPal, allowing for better security of the account.

4.4 Data Source

We intend to collect raw sports-related data from the SportSG Sport Facilities and SportsFields@SG on <https://data.gov.sg/>. The dataset contains basic information about sports facilities such as name, location, and type. By utilizing the Google Maps JavaScript API, we can visualize activities on an interactive and customized map.

4.5 Implementation

4.5.1 Web App Server

We implement the web development on Node.js with Express as the web application framework, EJS as templating engine, and Bootstrap as a front-end component toolkit for mobile responsiveness.

4.5.2 Github

Source code for our service can be made available on Github. This will also facilitate our Auto Scaling Setup, where a newly launched EC2 instance will retrieve the source code from Github to set up the web app server that will be hosting the site.

5. Limitation and Further Improvement

PlayPal is currently limited by available sports-related data from SportSG Sport Facilities and SportsFields@SG from the Singapore government website. There might be far more sporting facilities (e.g private sporting facilities) that are not captured within the database. Thus, PlayPal could collaborate with the Ministry of Sports to retrieve such information to ensure that the application is all-encompassing, so as to cater to all types of sports users and sports available in Singapore.

6. Approach

1. Homepage - PlayPal is designed to be a web app that is mobile responsive. Guest users are able to see activities being hosted by other users on the homepage

The image displays two versions of the PlayPal web application: a desktop view on the left and a mobile view on the right.

Desktop View (Left):

- Header: PlayPal logo, navigation links (Join a Game, Host a Game, About Us), and buttons for Register and Login.
- Section: "Welcome to PlayPal" and "Events Happening Around You!".
- Filter: "Filter by Sport: Show All".
- Table of events:

Date & Time	Location	Host	Sport
23/02/2022, 11:00 am	Ang Mo Kio Avenue 1	Shaunn Tan	Basketball
24/02/2022, 11:00 am	Bukit Batok West Avenue 5	Shaunn Tan 2	Golf
25/02/2022, 12:00 am	Bishan Street 14	David Tao	Soccer
01/03/2022, 5:00 am	Bukit Batok Street 22	Shaunn Tan	Golf
02/03/2022, 5:20 pm	Bishan Street 14	Gary Ong	Basketball
23/03/2022, 12:08 am	Evans Road	hui test	Handball
27/03/2022, 11:00 am	Aljunied Crescent Avenue 1	Shaunn Tan	Golf
01/04/2022, 3:30 pm	Aljunied Crescent Avenue 1	NN NN	Golf

Mobile View (Right):

- Header: PlayPal logo and a hamburger menu icon.
- Section: "Welcome to PlayPal" and "Events Happening Around You!".
- Filter: "Filter by Sport: Show All".
- Text: "Select an event to join!".
- Table of events:

Date & Time	Location	Host	Sport
23/02/2022, 11:00 am	Ang Mo Kio Avenue 1	Shaunn Tan	Basketball
24/02/2022, 11:00 am	Bukit Batok West Avenue 5	Shaunn Tan 2	Golf
25/02/2022, 12:00 am	Bishan Street 14	David Tao	Soccer
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27/03/2022, 11:00 am	Aljunied Crescent Avenue 1	Shaunn Tan	Golf

2. Registration - creation of user profile, including preferred sports/timing/location preferences and uploading of personal profile picture.

PlayPal

Register!

More information about you!

Your Preferred Time (multiple-select)

Mornings
Afternoons
Evenings
Nights

Your Preferred Day (multiple-select)

Monday
Tuesday
Wednesday
Thursday

List your favourite sports:

Register!

PlayPal

Upload a profile pic!

Browse...

Upload!

- Homepage (Authenticated Users) - once a user is logged in, the recommendation system (supported by AWS Lambda) in PlayPal will show all the recommended similar users by location and sport, user can choose to join the activities by clicking on them

PlayPal
[Join a Game](#)
[Host a Game](#)
[About Us](#)

Shaunn Tan
Logout

Welcome to PlayPal

Events Happening Around You!

Filter by Sport: Show All

Select an event to join!

Date & Time	Location	Host	Sport
25/05/2022, 3:00 am	Woodlands Street 12	Bandal Mench	Handball
24/08/2022, 6:00 pm	Anchorvale Road	Patricia McGehee	Basketball
16/08/2022, 6:00 pm	Woodlands Street 12	David Boscio	Handball
23/07/2022, 3:00 am	Anchorvale Road	Jerry Murray	Track
26/06/2022, 6:00 pm	Yishun Avenue 1	Sallie Arnold	Tennis

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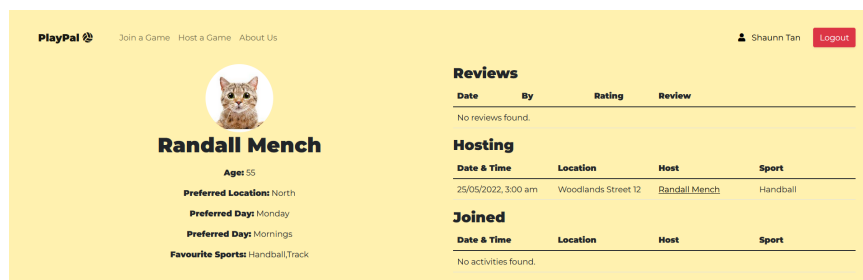
- Clicking on any of the activities on the screen above allows the user to review the exact details of the activity and access the host's profile.

PlayPal
[Join a Game](#)
[Host a Game](#)
[About Us](#)

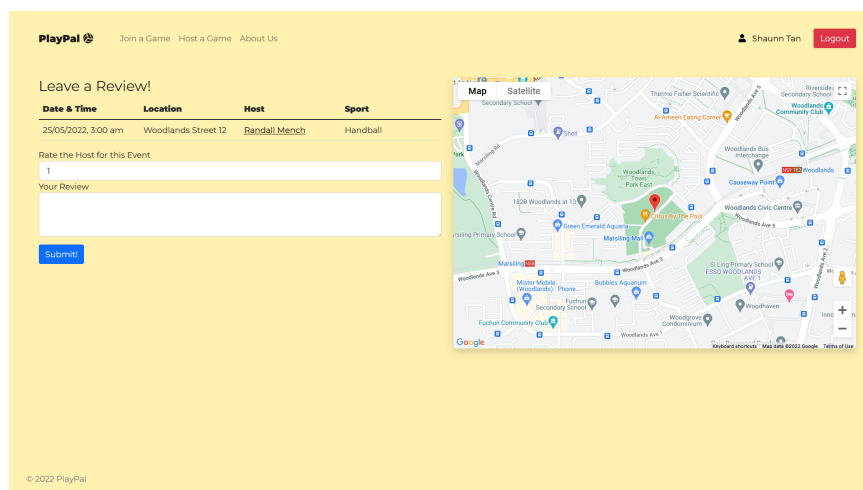
Shaunn Tan
Logout

Date & Time	Location	Host	Sport
25/05/2022, 3:00 am	Woodlands Street 12	Bandal Mench	Handball

Join Team!



- After the event, users can choose to leave a review for the host of the activity and rate them so that other users can view the shared experience.

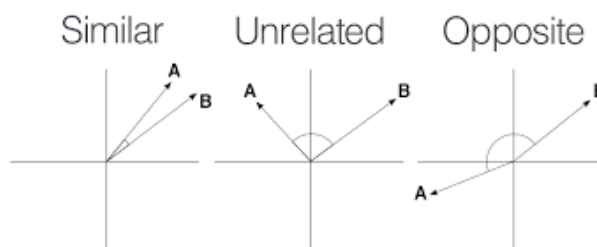


6.1 Recommender (AWS Lambda)

We retrieve a list of relevant users which match the logged-in user's vicinity and the activities hosted by such users nearby. PlayPal will send the aforementioned results as a payload to AWS Lambda to process and which returns a sorted list of the most recommended activities to be rendered on screen.

A collaborative filtering algorithm is utilized whereby PlayPal will recommend users based on a similarity measure (cosine similarity) between the authenticated user to other users stored in the MongoDB database. The basic assumption here is that users with similar interests have common preferences for activities.

Using cosine similarity as a metric, the larger the cosine similarity score (closer to 1), the more similar the two users are.

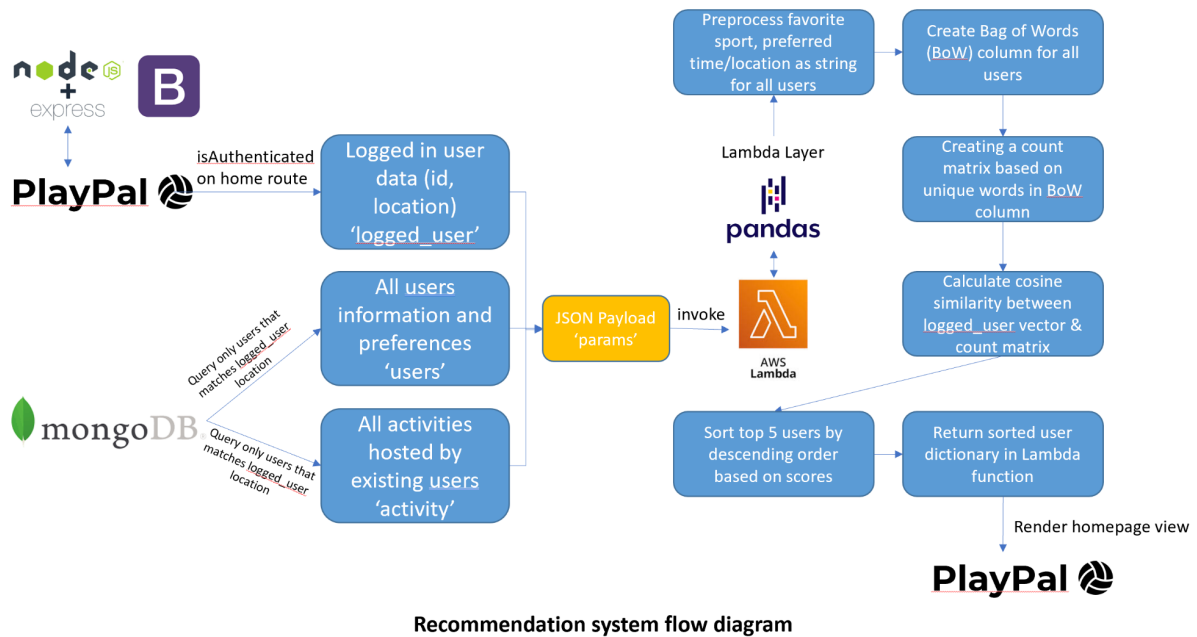


With the retrieved user information, the following steps explain the workings of the implemented AWS Lambda function:

- Create a bag of words for the characteristics of each user

- Utilize cosine similarity to measure how similar the logged-in user is to the rest of the users.
- Sort the users list by descending similarity scores.
- For the top five most similar users, retrieve their hosted activities for display on the logged-in user's homepage.

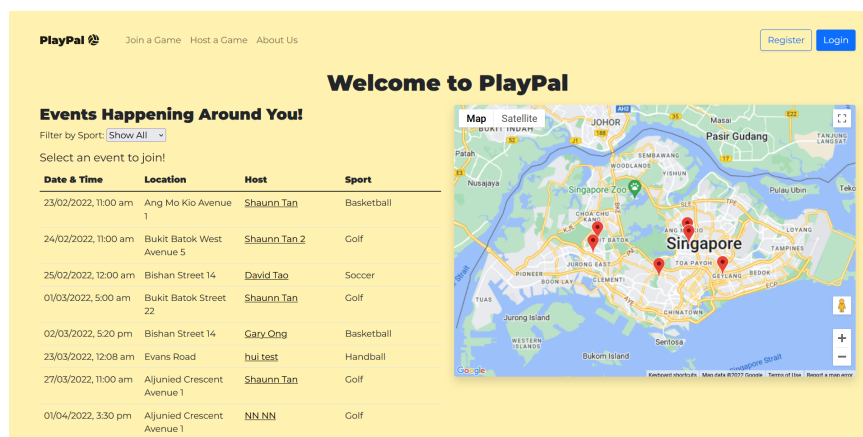
Recommendation system flow diagram:



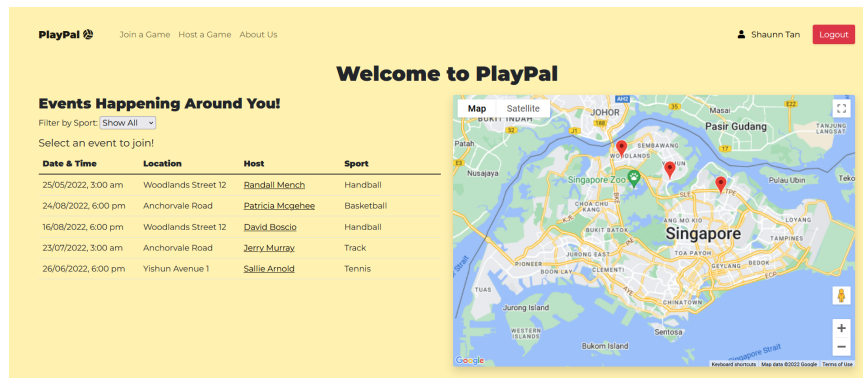
Recommendation system flow diagram

A demonstration of the AWS Lambda function:

- Before login, the user is shown a general list of activities.



- After logging in, recommended activities are shown instead



For this user, the preferred location was North of Singapore.

7. Economic Factor

7.1 Economic Benefit

There are two main economic benefits of the application. The first impact is the direct revenue generated for our business which can be earned from four envisioned monetisation channels associated with different functionalities of PlayPal as follows:

1. Advertisement-based Revenue

A third-party ad system, such as Google AdSense, can be embedded in PlayPal. The placement of advertisements includes the discount promotion of sports products/services to attract users to visit the website. The revenue by displaying ads on the application is generated from the website traffic.

2. Affiliate Revenue

The application may eventually provide the function to display and sell sports products/services of affiliate programs during the event booking procedure. Since such products (sportswear, sports drinks, and equipment) are likely to be good compliments to the user activities, PlayPal could generate good revenue for the affiliated products and affiliate revenue when users click on affiliate links or purchase affiliate products/services successfully.

3. Boosting Revenue

Individuals can purchase a package to boost their events to be displayed at the top rank, enabling greater visibility for events that are lacking in players when event date is nearing, and users have the urgent need to make up the numbers required.

4. Commercial Event Listings Revenue

Cooperates of sports businesses could purchase a package to boost commercial events to a broad audience and sell tickets for the events via PlayPal. The revenue is earned from the sold package and the commission share of sold tickets. Sports businesses could be incentivized to promote their events through PlayPal due to it being the one-stop-shop for all sports-related events and its recommendation system to attract the right crowd.

The second economic benefit is an indirect impact on the public health in Singapore. The application provides accessible sports information and allows users to participate in events based on their interests, increasing sports participation in Singapore. With improving physical health activity rates, national healthcare expenditure could be reduced. PlayPal could work with MOH to receive nation-wide funding for the deployment and support of infrastructure to manage the application to ensure Singaporeans have access to the app.

7.2 Key Considerations

The demand for participating in sports activities may increase significantly during the period of big competitions, for example, more users are likely to play particular sports or to purchase tickets for ASEAN Football Federation, a commercial competition in Singapore. The business model could take advantage of such peak periods to earn higher revenues. The price of the advertisement and boosting can be increased during such times, and this is a cost borne by the advertisement provider.

7.3 Pricing Models

With the cloud architecture, our service avoids the upfront cost of facilities, hardware installation, maintenance and administration. At the early launch, the revenue generated from the service will be mainly spent on the cost of the database, NAT Gateways, Elastic Load Balancer, AWS PrivateLink, AWS EC2, AWS S3, AWS SES and AWS Lambda.

The following major cost and revenue breakdowns are calculated for the AWS region Asia Pacific (Singapore) for a 720-hour month:

Item	Count	USD/720-Hour Month
NAT Gateway	2	92.04
MongoDB Atlas (M10 instance)	1	57.60
EC2 (t2.micro instance)	2	22.94
Elastic Load Balancer	100GB per month	21.24
S3	10GB/100GB per month (Storage/Transfers)	12.27
PrivateLink	1 endpoint	10.49
	Total Cost	216.58
Google Adsense Revenue	5000 views	426.00
	Net Income	209.42

Other costs for Lambda and AWS SES are deemed minor and excluded from the computation.

At the current initial stage, we aim to apply an on-demand pricing model to run the service. When the service is deployed to production successfully and sustainably, there will be an

increase in demand and workload fluctuation. We may consider reserved pricing as an alternative option for reserving instances for the users.

We estimate 5,000 AdSense views each month, bringing in USD426 in revenue.

The net income for a month is approximately USD209.42.

7.4 Tradeoff between cost and service level agreement (SLA)

As a cloud-hosted service, we estimate the availability of 99.95% following industry standards.

Response time for showing recommendations to users is higher, due to data being retrieved from MongoDB Atlas and processed by AWS Lambda on request.

While our data comes from external sources maintained by the Singapore government, we cannot ensure its continuous availability.

8. Conclusion & Future Work

Playpal is an AWS cloud-based web service to provide accessible sports information and a recommendation system to suggest the most relevant activities based on user preferences.

The application seeks to address the problem whereby the general population either has no one to play sports with, or friends being unavailable for such activities, which we evaluated from the National Sports Participation Survey (NSPS).

In our future work, we will focus on enhancing the web app and introducing features related to the revenue-generating process to increase earnings.

Further, we can cooperate with the Ministry of Sport and Ministry of Health to support sports and health information campaigns, to push forth the narrative that sports play a crucial part in every individual's life, at the same time garnering greater usage and support of PlayPal for higher revenue generated.