Play Store Database Management System

Kunj Joshi, Dhyey Shah, Krishna Patel, Dhrumin Patel, Moksh Vaghasiya, Jeet Kanani, Dr. Nishant Doshi (Sr. Author)
Computer Engineering, School of Technology, Pandit Deendayal Energy University, Gandhinagar, India

Abstract
Ever since Google released its Android App Distribution market, Google Play, aka Play Store, it has become one of the biggest App Markets in the world. With millions of apps available to be downloaded daily, we need a Database Management System, which can keep track of every aspect provided by the Play Store for every Application. In this research, we created an efficient and working Play Store Database Management System, which provides information of every kind possible, about an app on the Play Store along with additional information about certain features of the Play Store. The DBMS was coded in SQL and its Relational Model and Entity Relationship Model were created using draw.io tool. We researched the uniqueness and usefulness of the DBMS created. The findings showed that this was one of the most unique and detailed, efficiently working DBMS. It covered every generic aspect of an application and categorized them on basis of features available on the Play Store. It can be considered as a useful-tools for Developers and Users who can use the System to their avail. Developers can use it to expand their market and make their apps better; while users can use the System to search for the apps they want to download easily. The authors can claim that there has been no prior research made in the direction, according to their best knowledge. The research and its results are completely original and not at all biased on any kind of factor possible.

Keywords- Google Play Store, Database Management System, Apps, SQL

1.Introduction

Google Play Store was originally released as Android Market back in 2008. It was renamed to Google Play, aka Google Play Store later on in 2012. It was a merging of Android Market, Google Music and Google eBookstore and contained items from all the three distributed on a single platform. [1] Play Store Stands today as one of the biggest App Distributing Markets. As of 2019, Play Store had had an estimated total of 2.6 Million applications available for downloading and as of 2021, 352.9 billion apps are downloaded daily. [2]

This shows what a giant market Google Play Store has become and as the Play Store expands more and more, it becomes a mammoth task to manage the application data on a daily basis. This calls for the requirement of an efficient Database Management System to manage all the data provided on the Play Store. We have achieved an almost perfect Database Management System, called the Play Store Database Management System (called PDBMS now onwards).

Google incorporates a complex search algorithm in their Play Store which provides the best applications under any Category to its users. [3] They also incorporate an AI-powered software catering to user specific needs. As of 2014, Google started providing transparency to its users, as now they had access to the size, reviews and ratings of what applications they were using [4], also allowing them to rate their favourite applications on a scale of 1 to 5 stars (1 being the worst and 5 being the best) [5], and also allowing them to leave a feedback through a comment section for each and every application [6]. Thousands of apps are uploaded by developers to be downloaded, daily on this mammoth market. This needs an efficiently working Database System to store data of every aspect, that Play Store provides for each and every application. Play Store's features don't stop here, it allows developers to advertise their apps on other platforms [7] and also add discount offers to them [8] using Play Console, it allows developers to bring new updates to their apps which satisfies

their users [9], Has an extraordinary Ranking system [10] and provides users with extra ordinary features such as Beta Version [11] and Editor's Choice to choose apps which suits them.

This leads us to a question. Is the PDBMS efficient enough to cover all these aspects and provide a detailed insight to all these aspects for every application? The short answer is Yes. The PDBMS incorporates all of these features through relations and their attributes and also has developed interlinks between features that are inter related. As of now, The PDBMS has acquired data of over 6000 apps available to be downloaded from the Play Store. The PDBMS has been generated to be, not only one of the most user friendly, but also one of the most Developer friendly Database Management Systems. The Dataset used is one of the most detailed datasets available on Free Data Mine, Kaggle.com [12] and has been cleansed by following the instructions of [13]. Some data wasn't available in the dataset and had to be generated using trustworthy Microsoft Excel RAND and RANDBETWEEN functions.

The PDBMS can be represented using the Relational Database Model and the Entity-Relationship Model. Relational model is a model to represent data in the form of relations or tuples. The relational model is used to create the database using any RDBMS languages.[14] ER model is a way to represent the data in logical view which consists of these components Entity,Entity type, Entity Set.[15]

Some of the most unique features of the PDBMS includes containing data about Apps Advertised, Apps With Discount Offers, Apps Deleted from Play Store, Developer Information, A brief and detailed User information (which ranges from the user's name and age to their subscriptions, downloaded apps and payment methods used), Beta Version, an efficient Ranking System (which ranks the paid and free apps along with a general Top Charts list and an outstanding feature showing the App that trended the Most In The Entire Week) and Editor's Choice.
The PDBMS is coded in SQL (Structured Query Language) and has had many working queries tested on it to make sure no discrepancies have crawled into the system and is as much efficient as possible.
Looking at the working of the PDBMS, we decided to work on the following Research Questions:

RQ1: *How is the PDBMS unique from other Database Management Systems and the Play Store itself?*
RQ2: *Who would be the most benefited by the PDBMS?*

Here is how the Paper has been divided. Section 2 contains the Methodology involved in creating the PDBMS, Section 3 contains Review of Literature, Section 4 contains the Proposed System which involves the Framework of The System, along with the Relational and ER Models of the PDBMS, Section 5 contains Experimental Analysis of the PDBMS, Section 6 has the Results and Conclusions of the Research while the final Section 7 details the Limitations of The Study and its Scope of Future Research.

2.Methodology

All the authors met together on Google Meet to discuss the detailing of PDBMS as it was impossible to meet face to face due to the Covid 19 Pandemic. The designing of PDBMS began once all the details were discussed. The authors used the SQL Workbench 8.0 CE to create the PDBMS. The Relational Model and The ER Model were generated using the draw.io Tool. We also used the convertcsv.com [16] tool to generate the INSERT INTO statements.

3.Literature Review

Studying about Google Play Store Dataset has been one of the biggest attractions for Data Scientists and Machine Learning Experts because of various trends and features it provides. We have studied some of the literature written on the same and divided it into three different categories according to our research.

3.1) Study On Google Play Store:

Many researchers have researched on Google Play Store Datasets over the years, specifically making crawlers to go through the Play Store. Vienott et al. [3] made a Play Store Crawler to collect data about the applications available on the Play Store and found various loopholes, such as leaked secret authentication keys in Google Play Store. They also generated an efficient mechanism to collect and store data about applications, which they named Playdrone. Callaham et al. [4] did a brief research on the changes that were incorporated by Google in its Play Store design through the years of its success. Google decided to merge all its different services it offered into one service, they collectively called Google Play. In 2012, they solved difficulties faced by the users due to not owning credit card or debit card, by introducing Google Play Gift cards to allow them to purchase items directly from Google Play. In 2014, Google decided to become more transparent with its users by providing data about the applications users were interested in like ratings, reviews and file size amongst others. Dey, Beheshti and Sido et al. [17] used a Play Store Crawler to have a check on Play Store Apps and rectify the malicious ones. Their reports identified around 2% of the total app population to be a malware. Such applications which did not meet with Google's Terms and Conditions are deleted from the Play Store on daily basis [3].

3.2) Study on Play Store Apps:

This field of study has mainly attracted researchers who are trying to research app ratings on Play Store and its relation to other factors as ever since the instalment of ratings and reviews feature on the Play Store, developers have focused on bringing in more positive ratings and reviews, directly connecting them with app popularity [18]. Olmstead and Atkinson et al. [19] did a research on all the applications on the Play Store and brought out statistical data related to the features of the apps. The Play Store majorly contains apps belonging to about only eight categories, as identified by the Play Store and most of the applications available were free to use. She also threw light on Google's preloaded apps in Android smartphones and their updating frequency. McIlroy et al [20] studied about the update frequency of the applications on Play Store and directly connected it with growth rate of the apps. His research showed that a significant percentage of applications have been updated bi-weekly while a very little percentage of applications have been updated weekly. Schmidt-Kraepelin et al. [18] did a research on the popularity of Mobile Health Applications and their direct relation to game Mechanics inserted in them. Their research showed that Gamification process in apps showed hugely promising results for the developers as their apps were used by the users for longer time than apps not having gaming mechanics. McIlroy et al [6] in their another Paper researched on the Ratings of applications whose developers provided feedback to the users. Although they found that a very small amount of app developers responds to their critics on the Play Store, them ensuring the users of features or receiving praises from the users did increase their app ratings. Hecht, Mouvoy, Moha and Duchien et al. [21] developed a system called PAPRIKA which detected Anti-Patterns producing in the applications of the Play Store.

3.3) Study on The Unique Features:

To our best knowledge, there has been no research conducted which contains all the unique features being explored together. Our research paper is one of the firsts of the kind to do so in a

Database Management System related approach. Malavolta et al. [22] researched the Hybrid Apps on Play Store from the End User's Point of View in a research unique in its own kind. Their research gave the result that the End Users usually just cared about applications working properly on their smartphones. They found out that Users usually preferred apps which worked on various platforms (Hybrid Apps) rather than Platform-native Applications. Choi and Chen et al. [8] researched one of the unique features that is effects of discount pricing on gaming applications. They formulated many hypotheses which all pointed to the positive effect of Discount offers on gaming applications. Their results concluded that under many cases, discount pricing had helped Gaming Applications grow, but under some circumstances, discounts have also led to users not trusting the applications. Ahsanuzzaman et al. [7] did a research on the Evolution and Integration of Ad Libraries in Google Play Store and concluded that ads were really helpful for the advertising developer to spread their product.

4.Proposed System

4.1 Framework

The proposed Database Management System (DBMS) covers up various features provided by the Play Store, which would be briefed one by one in the subsequent paragraphs.

The PDBMS contains information of over 6000 applications such as their Content Rating, their Genre and Category, their Current Version, Date of the Last Update, Size, Price, Release Date, Number of Downloads, Android Requirements, Permissions Needed, Reviews, Ratings and Feedback. Instead of browsing through all the application screens to read about these features, these are provided in a tabulated format in the PDBMS. It also contains information related to various developers who have uploaded their applications on the Play Store.

This PDBMS provides a technical overview of application details. All of these basic data help users choose an application they might want to download. For Eg. The Number of Downloads and Ratings features have helped many users make a decision regarding downloading an application as they rely heavily on the data provided to them on their screens [18]. Similarly, the Feedback mechanism in the Play Store's Comment Section as shown an increase in user Ratings for apps where developers have provided Feedback to their users [6]. The Success of an Application is heavily based on the positive and negative reviews it gets, something that has been fairly distinguished in the PDBMS.

One of the most unique features of the PDBMS helps the developers to advertise their applications and provide discount offers on them as these are two of the most effective methods of advertising today. [8] On the other hand, it also helps users to check details of the advertisements they are watching or discount offers they might want to avail. The PDBMS provides data for the Advertised Apps such as their Ratings, Number of Downloads and the Country of their advertisement. On the other hand, it provides data such as Discount Percent and the Start and End Date for any discount offer on any application. Another unique feature of the PDBMS involves an efficient ranking system, also used by the Play Store [10], and provides data of the top applications under any category. The Google Play Store provides data of only the top 500 applications under any category [3]. The PDBMS has differentiated the best applications into Top Paid and Top Free lists. The Play Store uses a recommender system to recommend the best apps according to the requirements of users based on factors such as number of downloads and user reviews.[3] The PDBMS also provides a Top Charts and Editor's Choice list, which are some of the unique features of Google Play Store. But the PDBMS stands out from the Play Store with a new feature of "App of The Week" where the PDBMS features the most popular app from every category on weekly basis. The Ranking System used by the Play

Store has been one of the most efficient ways to encourage developers to improve their apps and encourage users to download applications which have topped the charts. [10]

One of the most striking features explored by the PDBMS involves the Users. Users are the most important factor for any application on the Play Store. User feedback comprises on various factors affecting app functionality. Their reviews are evaluated in various ways by the developers to improve the apps as much as possible.[3] The PDBMS provides us with every detail about the user, from their names and ages to their Payment details and subscription details and apps downloaded by them. This marks as one of the most complete developer friendly database system as they can easily check and know their target audience. This also helps users find applications which are liked by similar users and make their work easy to find and download the applications. [22]

4.2 Relational Model and ER Model

4.2.1 Relational Model:

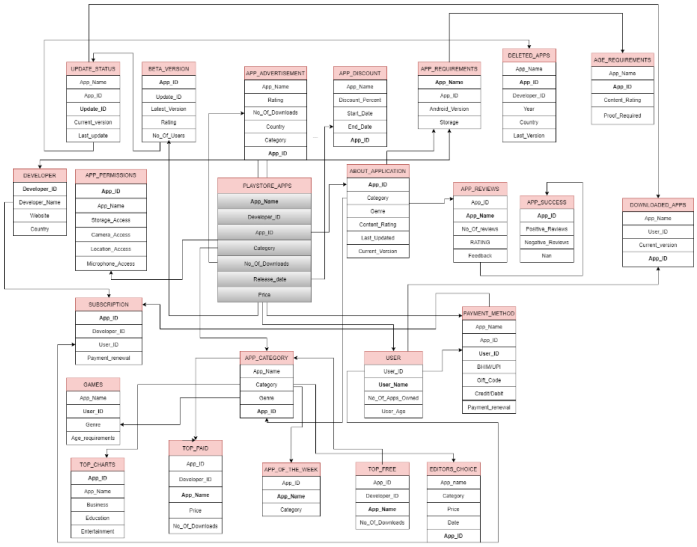

Figure 1. Relational Model of The PDBMS

4.2.2 Entity-Relationship Model:

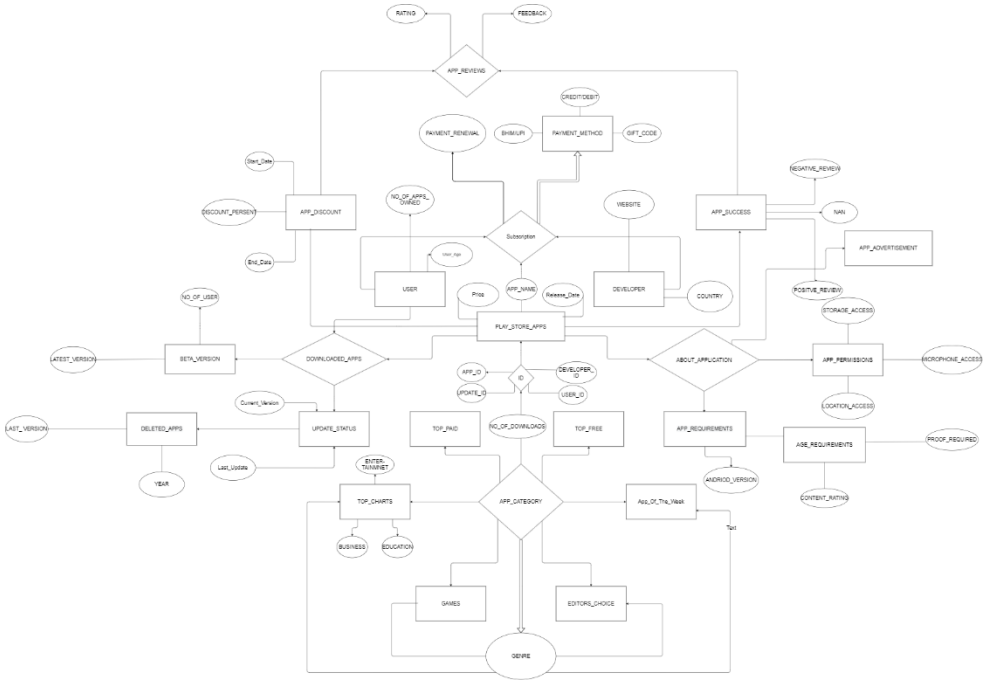

Figure 2. ER Model of The PDBMS

5. Experimental Analysis

The experiment carried out was simple. The main aim was to develop an efficient working Databased Management System. We carried out the experiment by writing the CREATE TABLE Queries for the 24 relations that we had discussed would be on the PDBMS. The final task involved writing working Queries to ensure that the interlinks between the Relations were efficiently working and there had been no discrepancies which would have crawled in the System. Here are a few of the Queries which we used to ensure no discrepancies:

1) *Question: Display names from all the apps common apps from Top paid and editor's choice with price less than 2 dollars*
Query: SELECT App_Name FROM TOP_PAID where Price< 2 UNION App_Name FROM EDITORS_CHOICE where Price<2

App_Name
Mupen64Plus AE (N64 Emulator)
Android P Style Icon Pack
Light X - Icon Pack
B-17 Flying Fortress WWII LWP
Pacify (Android P theme) - Theme for Xperiaâ„¢
Q-slope
Michael's AG Sound Board
W Pro - Weather Forecast & Animated Weather...
Analog and Digital Clock AW-7PRO
Car Driving Theory Test BC
Theme Android P Black for LG G7 & V35
Pureness Pacify (Android P) - Theme for Xperiaâ„¢

Figure 3. Query 1's Execution returned a total of 980 Rows

2) *Question: Get the names of all Users who have downloaded ROBLOX*
Query: SELECT User_Name from USERS WHERE EXISTS (SELECT User_ID From DOWNLOADED_APPS WHERE USERS.User_ID=DOWNLOADED_APPS.User_ID AND App_Name='ROBLOX')

User_Name
Pamela Mcmillan
Ivan Wall
Julianne Cooke
Katrina Mayer
Tristian Nelson
Jamarion Rich

Figure 4. Query 2's Execution returned a total of 6 Rows

3*) Question: - Display the details of all the apps having Rating 4*
Query: SELECT * from APP_REVIEWS having Rating = 4

App_ID	App_Name	No_Of_Reviews	Rating	Feedback
12	50 Healthy Slow Cooker Recipes	359355	4.0	Negative
15	Masha and The Bear	189434	4.0	Neutral
31	Dating Network	768719	4.0	Positive
43	Mad Libs	837133	4.0	Negative
79	Lifetime - Watch Full Episodes & Original Movies	631275	4.0	Negative
123	Access Point Names	265274	4.0	Positive
160	LOVOO	951949	4.0	Positive
193	Navmii GPS USA (Navfree)	811963	4.0	Positive
220	Game of Thrones: Conquestâ„¢	191093	4.0	Neutral
226	CAPTCHA Pack for Sleep as Android	40455	4.0	Neutral
227	The Maze Runner	114716	4.0	Positive
236	Onet - news, weather, sport	771698	4.0	Neutral
238	Camera ZOOM FX - FREE	114581	4.0	Neutral

Figure 5. Query 3's Execution returned a total of 533 Rows

4) *Question: Display the names of Users and their Payment Details only for those who use Credit Query:* SELECT * from USERS ur INNER JOIN PAYMENT_METHOD pm ON ur.User_ID=pm.User_ID WHERE pm.CreditDebit='Credit'

User_ID	User_Name	Noof_apps_owned	User_Age	App_Name	App_ID	User_ID	BHIMUPI	Gift_Code	CreditDebit	Payment_renewal
U0124	Londyn Howell	33	14	Strawberry Shortcake BerryRush	500	U0124	No	j6KLdYD	Credit	Yes
U0089	Ivan Wall	14	73	UFC	501	U0089	No	0PWrZoS	Credit	No
U0101	Kaylyn Shea	44	33	U + professional baseball	502	U0101	Yes	kvvBqgu	Credit	No
U0431	Julie Hays	50	58	Open Camera	504	U0431	No	5dR8Zsd	Credit	Yes
U0091	Elena Santos	8	37	InfantRisk Center HCP	505	U0091	No	7tkBuxw	Credit	Yes
U0100	Virginia Bartlett	27	62	All Video Downloader	512	U0100	Yes	kUYR8OL	Credit	Yes
U0003	Marissa Hayden	50	41	Sway Medical	513	U0003	Yes	XslbX9y	Credit	No
U0124	Londyn Howell	33	14	ChatVideo Meet new people	514	U0124	No	a2elShs	Credit	No
U0089	Ivan Wall	14	73	Photo Compress 2.0 - Ad Free	515	U0089	No	pNZJdqg	Credit	No
U0101	Kaylyn Shea	44	33	palmPEDi: Pediatric Tape	516	U0101	Yes	E5c5w53	Credit	No
U0091	Elena Santos	8	37	Innovative: Learn 34 Languages	519	U0091	No	1K5Q9Ew	Credit	No
U0213	Hugo Booth	49	24	EliteSingles â€" Dating for Single...	523	U0213	Yes	GB2kchf	Credit	No
U0100	Virginia Bartlett	27	62	JOANN - Crafts & Coupons	526	U0100	No	zDBOd7B	Credit	Yes

Figure 6. Query 4's Execution returned a total of 469 Rows

5.1 Uniqueness of our Paper (Feature Table)

Paper	F1	F2	F3	F4	F5	F6	F7
[1]	Yes	No	No	Yes	Yes	Yes	No
[2]	Yes	Yes	No	No	Yes	Yes	No
[3]	Yes	No	No	No	Yes	Yes	No
[4]	Yes	No	No	No	Yes	Yes	Yes (Only inclusion of Feedback System)
[5]	Yes	No	No	No	No	No	Yes (Only inclusion of App Advertising)
[6]	Yes	No	No	No	No	No	Yes (Only inclusion of App Discount)
[7]	Yes	Yes	No	No	No	Yes	No
[8]	Yes	No	No	No	Yes	No	No
[9]	Yes	Yes	Yes	Yes	No	No	No
[10]	Yes	No	No	Yes	No	Yes	No
[11]	Yes	No	No	Yes	No	No	No
[12]	Yes	Yes	No	No	No	Yes	No
[13]	Yes	No	No	No	Yes	Yes	No
[14]	Yes	Yes	No	Yes	No	No	No
[15][1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] Refers to this Research Paper

Table 1. Comparison of our study with other studies in the same domain and proving its uniqueness[i]

Feature	Description
F1	General Information regarding any application on the Play Store such as App Name, its category and genre, size, price, number of downloads, developer, Content Rating, requirements etc.
F2	Information regarding Updating any application available on the Play Store. It provides data such as current version, and last updated date to synchronise with all the updates the application has had.
F3	Information about any application in its Beta Testing Stage. It is a pre-release version, where developers can take reviews of their next update from their users. Provides information such as Latest Version, Rating and Number of Beta Users
F4	Information about the Users who use the Play Store. It includes all information from their name and age to their Payment Details and Subscriptions and Apps Downloaded by Them
F5	The Ranking System incorporated by the Play Store. It ranks all apps based on their ratings into lists such as Top Free, Top Paid and Top Charts. Also includes Editor's Choice option where the best apps chosen by specialists prevail
F6	The Rating System incorporated by the Play Store. It allows user to rate apps from 1 to 5 stars (1 being worst and 5 being best). Also provides information regarding the number of reviews, whether positive or negative and Feedback acquired from the Developer.
F7	Tools that would help a Developer improve his app and expand his market such as App Advertising, Discount Offers on App Purchases and Providing Feedback to their Users.

Table 2. Description of Features in Feature Table

6. Results and Conclusions

As shown by the research, the PDBMS is one of the most efficient Database Management Systems with a vast amount of data contained within it. It does not only cover the General Features of an Application but also covers up all the Specific Features provided by the Play Store along with incorporating a few new and unique features as well. We researched primally on two Questions and here are our findings regarding the both.

RQ 1: How Is The PDBMS unique from Other Database Management Systems and The Play Store itself?

With 24 brief relations and over 1,39,000 values filled in the attributes, the PDBMS stands as an efficient and detailed systems of its kind. The striking features that differentiate the PDBMS from the Play Store include "App Of The Week" feature, the feature to show "Deleted Apps" from a particular country and the feature which gives users a detail of all their "Downloaded App". It also incorporates an efficient searching system where by entering the required details, a user can definitely find the most specific application, he is looking for. The PDBMS doesn't lag behind the Play Store in the unique features of the Play Store itself, either. PDBMS contains data including the "Update Status" of the Apps, "Beta Version", "Editor's Choice" and the most important features i.e. The Ranking

System of the Play Store and the Rating System of the Play Store which cumulatively might account for an app's success.
The reason why PDBMS is better than other Database Management Systems is that it is the most detailed Database Management System. Out of the 24 relations, incorporated in the PDBMS, 15 of them correspond to the Unique Features provided by the Play Store and the rest 9 correspond to the General Features of the Play Store. The attributes involved in each of the relations are brief enough to explain the relation they represent in a detailed manner.

RQ2: Who would be the most benefited by the PDBMS?
On a brief research throughout the study, we can come to a conclusion that the PDBMS would be one of the most useful systems for two categories of people: The Developers and The Users. The real question arises then, who is benefited more?
The Developers can keep a check on their audience and applications simultaneously with the use of features such as "Downloaded Apps", "Deleted Apps", "App Success", "App Reviews" and "Subscription", they are also given the features of "App Advertisement" and "App Discount" by the PDBMS to expand their market. They can also get a review of their app, while its in Initial Stage of Development using "Beta Version" feature.

The Users are given features to choose apps that sync with their taste such as "App Category". They also have the choice to browse through apps which have been most liked by other users and have trended such as "Top Paid", "Top Free", "Top Charts", "App Of The Week" and "Editor's Choice". The users can also browse through the reviews and thoughts of other users as well before making their choice using the features of "App Reviews" and "App Success". The Users can also keep a track of their downloaded apps and app subscriptions using the "Downloaded Apps" and "Subscription" features. At last, the users are also given an open window to keep a track on updates regarding their favourite apps using "Update Status" feature.

As certain from above observations, Developers have received many positive features from the PDBMS which doesn't only allow them to improve their app, but also spread their market more. But the Users certainly have an edge in using PDBMS than the developers because of all their needs being catered so easily. So, the PDBMS benefits Play Store Users the most.

Finally, we conclude the research by saying that the PDBMS is one of the most efficient, detailed Database Management System which covers each and every possible aspect for the apps available on the Play Store. It is not only User-friendly, but also a Developer-friendly system which caters to the needs and requirements of both in a satisfying manner. The PDBMS also stands ahead of other Database Management Systems as more than 60% of its relations are unique and strikingly efficient. The PDBMS not only provides the unique data, but also caters to the general features of any application available on the Play Store. With more than 50 different assets of an application being explored by the PDBMS, through its attributes, we can easily conclude it as one of the best Database Management Systems of its kind.

7.Limitations and Further Study:

While the PDBMS might be a detailed, efficient system, it has its own backdrops. The first and certain backdrop is the lack of incorporation of an Artificially Intelligent System to make it a self-sufficient system. The PDBMS requires a Database Manager to operate efficiently and requires to be kept updated regularly. The option of self-updating hasn't been explored yet and can have a scope in the future. This brings us to our second limitation. The PBDMS was built on data, which was probably three years older than the system itself. It may not hurt the efficiency of the system statistically, but can be questioned on its authenticity in the present times. Hence, as a result, the PDBMS, if not updated regularly, may not remain as an authenticated system. The last limitation corresponds to

the data used. The dataset used to build the PDBMS was insufficient and hence required data to be generated by the developers. There might have been some discrepancies crawled into the system, by blinding the developers, even after a complete effort to remove the same.

Conflict of Interest

The authors can hereby confirm there is no conflict of interest to declare for this publication

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