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# Progressive Web Applications (PWA) : Combining the Advantages of the Web and Native Apps

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## ABSTRACT

This article examines the concept of Progressive Web Applications (PWA) as an innovative approach to development that combines the advantages of websites and native applications. It explores the technological foundation of PWA, including key components such as Service Workers, Web App Manifest, and HTTPS, which ensure high performance, offline access, and security. The study investigates the impact of PWA on improving user experience, cost efficiency in development, and their potential in various industries, including e-commerce and media. Special attention is given to the prospects of PWA application in the context of digital transformation and the further advancement of web technologies.

**Key words:** progressive web applications (PWA), web development, Service Workers, Web App Manifest, user experience, digital transformation, browser API.

## 1. INTRODUCTION

Progressive Web Applications (PWA) represent a next-generation approach to web application development, a paradigm mixture of the best of native mobile apps and classic websites. PWA use advanced web technology that is delivered with the best performance, flexibility, and usability both on browsers and on mobiles. PWA deliver offline functionality with fast performance and offer features which till now native apps enjoyed alone.

The basis of PWA rests in technologies like Service Workers, Web App Manifest, and HTTPS that allow applications to attain the web's flexibility coupled with the capability of mobile platforms. These solutions can reduce development costs and enhance user loyalty by improving the overall user experience (UX). Successful implementations of PWA in e-commerce, media, and service industries underscore their potential as a tool for digital transformation. The purpose of this article is to examine the key features of PWA, their technical underpinnings, and benefits, as well as to analyze the prospects for their adoption across various domains and their impact on the future of web development.

## 2. FEATURES OF PWA

The PWA strategy is a unique web application-mobile app hybrid with fresh user interaction possibilities. They are defined by the possibility of being used in a context of limited or zero internet connectivity. It is accomplished through the Service Workers, which provides resources caching and provides access to content during offline usage. It is a more reliable UX than normal websites, which are based on uninterrupted network coverage.

Another important aspect of PWA is that they are accessible through web browsers**,** so both the installation and usage become convenient. Users are not required to download the app from an app store; instead, the PWA can be installed directly from a website. This removes barriers for users as less effort and time will be spent accessing the application. It has the capability to auto-update itself, keeping them updated without the need for human intervention.

Interface adaptability is another central feature of PWA. These apps are designed to be compatible with a wide range of devices, providing a seamless and consistent UX on both desktops and mobile devices [1]. Regardless of screen resolution or OS, PWA interfaces are always easy to use and intuitive. This adaptability is of great worth in an era of increasing heterogeneity of digital devices.

These applications also perform well due to their utilization of modern data loading optimization strategies. Techniques such as resource preloading and partial data processing minimize wait times and enhance the responsiveness of interfaces. This is particularly helpful for people with slow internet connections or those who work in regions with low network capacities [2]. According to 2024 statistics and the start of 2025 [3], it is possible to observe a dynamic in the usage of various versions of the PWA project among Drupal sites utilizing the Update Status module. The trends show shifts in the popularity of versions, reflecting a gradual transition of users to newer releases (figure 1).

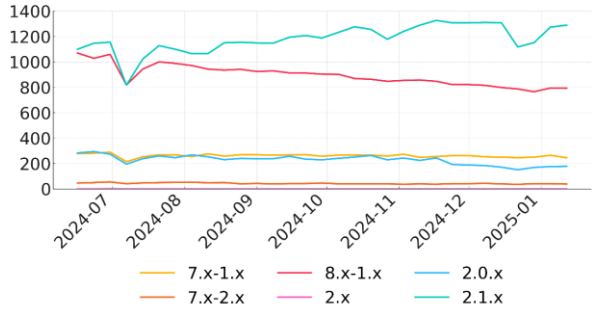


**Figure 1:** PWA usage statistics for period of 2024 and 2025 worldwide

Apart from their technical advantage, PWA are extremely valuable commercially too. PWA bridge the gap between web platforms and mobile operating systems, giving organizations a single application development strategy in a cost-effective way. All these aspects make PWA a powerful solution for organizations to enhance user engagement and raise conversion rates. PWA revolutionize the functionality of websites and establish a new standard for web development by combining accessibility with state-of-the-art technological features.

## 3. TECHNICAL FOUNDATIONS AND FUNCTIONAL CAPABILITIES OF PWA

The foundation of PWA relies on innovative technologies that enable their unique properties and excellent performance. Three fundamental elements are the primary focus areas in creating PWA: Service Workers, Web App Manifest, and HTTPS. All these form the basis of defining the operational and behavioral characteristics of progressive applications.

Service Workers are background scripts that a browser uses, and they play a primary function in enabling offline capability, managing network requests, and caching assets. Service Workers enable applications to execute even when there is no internet connection, thereby improving the UX. Service Workers have the ability to cache form information or previously viewed content, enabling users to access such data at any time. Service Workers also facilitate the use of push notifications, enabling applications to continue engaging with users.

The Web App Manifest is a JSON file that defines the basic parameters of a PWA, such as the application name, icons, color scheme, and start screen. The file informs a browser about a web application as installable. The manifest makes an installed PWA on the home screen of a mobile phone act like a native app. This approach improves access and raises user engagement, as PWA are regarded as standalone applications [4].

HTTPS is a mandatory requirement for the operation of PWA. The use of a secure connection ensures that data exchanged between the application and the user is protected from interference. This is particularly critical for PWA, which rely heavily on caching and interactions with browser API. Without a secure protocol, technologies such as Service Workers cannot function, as browsers block their use in unprotected environments.

One of the clear functional features of PWA is their ability to operate offline. This aspect is highly important to those living in regions where connectivity with the internet is poor. The support for offline access is provided by pre-caching, which allows users to continue interacting with the application with very few limitations. Applications like Google Maps allow users to access core mapping functions without an active network connection [5].

Another significant feature of PWA is their support for push notifications. This functionality allows applications to send important updates and notifications even when they are not in use in the browser. Push notifications are essential in keeping users active and are widely used in industries such as e-commerce and media in order to notify and engage users.

An adaptive interface is also one of the main components of PWA capability. They are designed with responsive design practice in mind, so they will dynamically adjust according to various screen sizes and device setups. This is made possible by the implementation of the latest Web standards like CSS Grid and Flexbox and UX-enabling JavaScript libraries. As a result of this, PWA can make all devices universally usable, hence increasing their usefulness for end-users as well as developers [6]. Blending with the hardware ability of the device increases the functionality of PWA even further. With the use of browser API such as Geolocation, Camera, or Web Bluetooth, PWA can talk to any device component, hence making them as useful as native apps. A PWA for a fitness tracker can retrieve location information or sync with wearable devices using available interfaces.

The technological underpinnings of PWA enable these applications to breach the confines of traditional websites and provide the user with features that were previously exclusive to native applications. The synergy of latest technologies and standards places PWA in the hands of developers as a formidable tool that can be leveraged to create game-changing and user-centric products.

## 4. ADVANTAGES AND PROSPECTS OF PWA ADOPTION

On the basis of a strategic assumption, PWA are not only a technical solution but offer companies new channels for interaction with consumers. With its unique set of features, such as improved performance, availability, and flexibility, PWAs are becoming increasingly popular in most industries.

One of the largest advantages of PWA is that they have the ability to enhance UX leaps and bounds. With instant load, offline support, and smooth performance even on low-technical-spec devices, PWA provide an accessibility that existed only in native apps until now. Push notifications and the ability to save the app onto the home screen add functionality, enabling companies to keep users connected at all times, thus maximizing total engagement. Corporations like Twitter and Starbucks have adopted PWA, and they have seen drastic increases in active users and in time spent engaging with their platforms.

From a cost perspective, PWA also have several benefits. First, their development and maintenance are less expensive compared to developing separate native applications for various operating systems. The use of a single codebase for all devices significantly reduces the cost of development and testing but accelerates the time-to-market. Second, the lack of a provision to distribute PWA through app stores such as the App Store or Google Play eliminates commission fees, which makes them particularly well-suited for small and medium-sized businesses.

The other distinguishing feature is their accessibility to the general population. Compared to native applications that an individual must download, PWA are accessible through a browser. The convenience is also appealing to consumers who do not wish to have loads of applications downloaded. Further, their offline use makes them of great utility in regions with poor internet connectivity, such as developing countries, where the increased application of PWA assists in reducing digital inequality.

The future of PWA adoption depends vitally on the continued development of the technologies and their more ubiquitous presence in all industries. In e-commerce, PWA have already demonstrated their effectiveness. Companies that have implemented these applications report a decrease in bounce rates, an increase in conversions, and a rise in sales. In the media sector, PWA enable users to access content quickly without downloading heavy applications, a feature particularly relevant for news platforms and video services (Table 1).

**Table 1:** Practical examples of PWA incorporation into various companies [7, 8]

| Company | Outcome |
|---|---|
| Kaporal | PWA experience resulted in 60% fewer bounces, 15% more conversions on desktop, 8% more conversions on mobile, a 40% increase in length of visit. |
| Kubota | A 192% growth of daily visitors and 26% growth of average monthly visits. |
| Starbucks | The company has increased daily active users 2x. Orders on desktop are nearly the same rate as mobile. |
| Devialet | A 2x increase in conversions and a 25% increase in organic traffic after launching a new PWA experience. |
| Lyft | Users on older devices take 11% more rides in Lyft's PWA than native users and click «Install PWA» 40% more often than «Download App». |

The future of PWA is also associated with the evolution of their functional competence. New web technologies such as WebAssembly and WebRTC will support the embedding of more advanced functionalities, such as video conferencing or data processing, directly into the browser. Ongoing improvements in browser API will provide a means to access new hardware capabilities, further improving PWA's comparative strength over native apps. Another equally significant direction for development is the support of PWA at the operating system level. Big industry actors are providing a major thrust towards the use of PWA by embracing them into their platform ecosystems. This implies that PWA will remain relevant and will also keep getting developed as per the demands of the market.

Deployment of PWA is an evolving solution for companies seeking digital transformation. With the blending of technological advantages, affordability, and user convenience, PWA have emerged as a vital component in modern digital solutions development. Their future is extremely rosy, foreseeing even greater extensive use and adoption in daily life.

## 5. CONCLUSION

The best features of native applications and traditional websites are harmoniously combined in PWA. With the implementation of advanced technologies like Service Workers, Web App Manifest configuration, and secure HTTPS protocol, PWA ensures simplicity, performance, and stability. Such applications provide a boost to the web space in functionality and provide scope to business once more with the cost-effective solution and extended access and enhanced UX. This trend is gaining pace within e-commerce, media, and services, with explicit influences on user experience and operational efficacy. With every technological leap and increasing browser capabilities, PWA will become stronger, unstoppable, and at the vanguard of digital transformation, remapping the way applications are being built.

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