Comparative study of XML vs Jetpack Compose for UI Development in Android

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Abstract- **There have been noticeable changes in Android Application development over the years, particularly in the area of UI design techniques. The traditional and standard method for building a UI in an Android app is via XML (Extensible Markup Language). In a similar fashion as all other sectors of technologies, Android is ever-evolving and enhancing their methods of building an intuitive user interface for their android apps by introducing - Jetpack compose. Jetpack Compose is a modern UI toolkit created by Google, and therefore, it is also providing developers an option that is advertised to be quicker to develop, more readable and easier to maintain. This research study presents a comparison of XML based UI and jetpack compose UI in regards to development time, code complexity, performance, learning curve, and ease of maintenance. By implementing the same UI screen using both coding techniques, and comparing the two coding techniques, we hope to provide developers an insight in regards to which development techniques are most applicable to different development situations. Through our findings, Jetpack Compose emerges with a clearer, more developer-centric coding structure, opening up new possibilities for developers when developing modern applications, however there is still room for XML in terms of legacy systems and established coding conventions.**

I. INTRODUCTION

1.1 Background Of Android UI Development

In the early days of Android development, UI design consisted of basic layouts and components with the main purpose for the apps to be usable, rather than how they appeared or if they engaged users. Developers mainly had basic tools to design these interfaces. As a result, apps often did not look very good or function very smoothly.

Another significant challenge in the early days of Android development was the multitude of Android devices of varying sizes and resolution screens. Developers often had to create multiple versions of the same UI in order to achieve a proper design for all devices. This process was tedious and many errors occurred.

In 2014, Google announced the release of Material Design, which completely transformed how Android applications were designed. Prior to the announcement of Material Design, individual apps all had their own designs, and there were no guiding design principles. Consequently, user experience felt disorganized and misaligned across apps.

Material Design was created to solve this problem. Material Design provides a set of well-defined design principles, so that every developer could use and follow prototype guidelines. They introduced design principles, such as, color contrasts with bold colors, animation transitions, and using realistic shadows - using ideas from the real world. Which left off by considering how light interacts with different surfaces in the environment. It is more than aesthetically enhancing app interfaces; Material Design intended to create a standardized project, so that every app developed along these guidelines would feel intuitive and look nice regardless of publisher.

Several years later, Google detained as much in the way of improvement and expansion of the Material Design system as development of Material Design you see today. Because as of 2025, we have Material You, the next cycle of Material Design. With more emphasis on personalization, Material You allows users to alter the way that the interface is designed by providing many options based on wallpaper color, theme style, and preferred preference options. The updates made to, with Material You advanced Android Interface more ahead in progress beyond Material Design to even more provide a more modern, user-centric experience.

1.2 Traditional Layouts & Rise of Jetpack Compose

Initially, Android app development involved users designing user interface (UI) in XML (Extensible Markup Language). Developers would create XML files that described where they wanted buttons, text, images, and other elements placed on the screen.

The beauty of this is that it kept the layout of the UI completely separate from the app's logic (the Java or Kotlin code). Separating these two parts of the app made it easier to build larger projects, because they became easy to manage and to understand.

However, managing that XML was not always easy. When designing more complex screens, the code could become quite long and complicated. Further, if the developer was looking for parts of the UI to always change while the app was being used (for example, showing/hiding buttons programmatically, or changing layouts based on user action), it required lots and lots of extra code to change the app at runtime following the original XML declaration. This ultimately led to apps being difficult to maintain and the potential for extra bugs in the system.

During this era of Android app development, both Eclipse (and later Android Studio, which was the main app development environment as of about 2013), had tooling that supported XML layouts with visual editors. This meant that developers could use tools that contained the UI Elements in the XML file and build screens by dragging and dropping the UI elements. While this made a developer's life somewhat easier in the XML world, they were not perfect. Many times the real time preview didn't realize the layout had changed, and the magical transition from visual view to code, often separated the development process in unfortunate ways as well.

Nevertheless, XML provided a large part of the backbone to Android early in its growth phase. It injected structure and standardization into app design in the early days of Android. As smart devices became more advanced, and with high user expectations, it quickly became evident that the need for a more modern and flexible approach to developing UIs would be required.

That's when Google released Jetpack Compose, which was officially launched in 2020, and by 2022 was being quickly adopted. Jetpack Compose meant developers could now create UI directly using Kotlin—no more separate XML files. Jetpack Compose improved the ease of creating dynamic app content that is interactive, using less code, and offering better performance from a developer's time spent using the app's UI.

Today, there is choice and technology options, and options for developers to build their UIs in different technologies. Many developers are unsure of the practical differences between XML and Jetpack Compose at the moment—many are focused on learning curves, how quickly and easy an implementation is, how easy it is to maintain, and what would offer the best performance.

To alleviate confusion developers and technology options it seems to be important to methodically compare the differences.

- The goal of this project is to carefully investigate XML and Jetpack Compose as Android UI technologies, and then compare both in real-world use cases.
- We are going to do the following:
- Examine the pros and cons of both XML and Jetpack Compose in the process of building user interfaces
- Assess the complexity of implementation for each, as well as the ease of the ongoing maintenance of the code, and the overall effect on developer productivity.
- Determine which toolkits have the best performance, scalability when considering app size, and flexibility of the toolkit itself.
- Ultimately, we want to provide guidance to developers and stakeholders by delivering the consideration necessary to choose a toolkit based on their needs and their team's experience.

II. LITERATURE REVIEW

The literature reviewed identifies the transition of Android UI development from XML to Jetpack Compose toolkit. Jetpack Compose has benefits such as declarative syntax, integration into Kotlin, reusable Composable functions, built-in state management, and speed to develop UI, leading to less boilerplate code and maintainable code. Inductive development tools for developers give Compose definite advantages to speed of getting started, start-up speed for low demand apps, and other modern paradigms. Conversely, XML is relevant today because it is a mature UI stack with predictable behavior, runtime stability and performance on low-end devices, and legacy system compatibility. XML has finer granularity for layout, IDE tooling, and normalized behavior across a spectrum of devices. However, Jetpack Compose has performance concerns such as CPU and battery cost of complexity for large compound apps, limited backwards compatibility with legacy apps, and is still maturing as an UI technology. XML is verbose and many contemporary developers will have a

steep learning curve with. XML also has limitations for modern UI response or needs with respect to real-time animations. While the literature contains many investigations of the performance metrics of JetPack Compose and XML, it has several research gaps with respect to long-term scalability, accessibility, hybrid integration, or developer productivity in existing applications.

III. COMPARATIVE ANALYSIS

Jetpack Compose - Advantages

S.No	Jetpack Compose Advantage	Description
1	Faster Startup & Rendering	Offers better app launch performance and smoother navigation animations.
2	Declarative UI Model	Simplifies UI logic by focusing on *what* the UI should look like, not *how* to update it.
3	Full Kotlin Integration	Built entirely in Kotlin, eliminating XML and reducing boilerplate.
4	Composable Functions	UI elements are modular, reusable functions for better code structure.
5	Recomposition	Automatically updates affected UI parts on state changes.
6	Memoization Support	Uses remember for caching and avoiding unnecessary recalculations.
7	Strong Encapsulation	Each Composable manages its own state, improving modularity.
8	Enhanced Tooling	Live Preview, Interactive Preview, and debugging tools in Android Studio.
9	Lower Coupling	UI and logic live in the same Kotlin file—more maintainable than XML.
10	Battery & CPU Efficiency	Lower CPU strain and optimized rendering in animations.
11	Single-Activity Architecture	Encourages a cleaner, more scalable architecture.
12	Kotlin-Only Language	Avoids context-switching between XML and Kotlin.
13	Event Handling Simplicity	Lambda expressions make event handling more intuitive.

S.No	Jetpack Compose Advantage	Description
14	Code Maintainability	Concise and scalable structure ideal for modern UI demands.
15	UI Flexibility	Composables and Modifiers provide rich customization.
16	Industry Adoption	Increasingly adopted by Google and large developer communities.
17	Improved Debugging	Recomposition tracing and UI Inspector improve diagnostics.
18	Adaptive Layouts	Easier to implement fluid UIs across screen sizes.
19	Better Memory Management (in low demand apps)	Lower memory consumption in simple use cases.
20	Easier Learning Curve (for Kotlin devs)	No need to learn XML separately; aligns with modern dev stack.

XML - Based UI - Advantages

S.No	XML Advantage	Description
1	Mature and Stable	Used for over a decade; battle-tested and consistent.
2	Faster Scroll Performance	Scrolls more smoothly in RecyclerViews and long lists.
3	Lower Jank	More stable frame rate and rendering in scrolling scenarios.
4	Better Performance on Low-End Devices	XML performs better on older hardware than Compose.
5	Explicit View Hierarchy	Provides granular layout control with View/ViewGroups.
6	Fine-Grained Layout Control	Attributes like layout_weight, padding, gravity enhance control.
7	Separation of Concerns	UI in XML, logic in Java/Kotlin—clear structural boundaries.
8	Rich Tooling Support	Layout Editor, ConstraintLayout Designer, drag-and-drop UI.
9	Predictable Rendering	Less variance in layout behavior and runtime performance.
10	Broad Compatibility	Works well with both Java and Kotlin; good for legacy apps.

11	Lower Battery Consumption	Less energy use in high-demand apps compared to Compose.
12	Lower CPU Usage	Less processor strain in medium to heavy UI operations.
13	Consistent Memory Use	More uniform across runs; predictable memory usage.
14	Backward Compatibility	Fully functional on lower Android API levels.
15	Visual Layout Preview	Easier to visualize and design UI in IDE without running the app.
16	ViewBinding/DataBinding Support	Built-in tools for automatic UI-data synchronization.
17	Fragment Integration	Works seamlessly with legacy Fragment-based architectures.
18	Easier Debugging (for Imperative Devs)	Familiar for those with a traditional development mindset.
19	Low Migration Overhead	Already standard in most existing projects; no big refactor needed.
20	Less State Management Overhead	Simpler UI apps require fewer reactive constructs.

IV. RESEARCH GAP

Despite the growing body of literature comparing Jetpack Compose and XML-based UI in Android development, several key gaps remain:

Gap Area	Description
1. Long-Term Maintainability	Few empirical studies track how Compose or XML scale in large apps over time in terms of tech debt, team productivity, or refactoring needs.
2. Real-World Case Studies	Many studies rely on synthetic benchmarks. More industry use-case-based studies (e.g., banking apps, gaming UIs) are needed.
3. User Experience Analysis	Very limited exploration exists on how UI built with Compose vs. XML affects user engagement or satisfaction.
4. Low-End & Legacy Device Performance	More data is required to understand Compose's performance on API 21–26 devices and less powerful hardware.
5. Battery Impact Over Time	Most Compose studies only benchmark short-term energy usage; long-term effects under typical user behavior patterns are underexplored.

6. Tooling Stability & Productivity Metrics	While Jetpack Compose claims faster iteration, quantifiable data on actual productivity gain in enterprise teams is minimal.
7. Accessibility Support	Limited comparative research on accessibility implementations and limitations in Compose vs. XML.
8. Hybrid Integration Scenarios	The complexities of integrating Jetpack Compose into large existing XML-based codebases are not deeply studied.
9. Cross-Platform Potential	No detailed examination of how Compose Multiplatform fits into UI strategies compared to traditional XML for Android-only apps.
10. Animation & Motion Performance	Although Compose supports advanced animations, real-world benchmarking under stress is sparse.

V. METHODOLOGY

In order to compare UI development in XML and Jetpack Compose in Android, a more experimental and hands-on approach was taken. The methodology employed design and development of the same user interface (UI) screens in both XML and Jetpack Compose to compare and evaluate the important aspects of development. Android Studio was used as the integrated development environment (IDE) and Kotlin was used as the programming language which is officially supported for development in Android.

The steps I took were:

1. UI Design Implementation:

We created two versions of the same screen using the following two methods:
Traditional XML-based layout files.
Jetpack Compose's declarative UI toolkit.

2. UI Elements:
We used common UI elements that can be implemented in both methods, including:
Buttons
TextViews / Text Composables
Cards
Lists / LazyColumn

3. Evaluation Criteria:
Both implementation methods were evaluated with respect to:

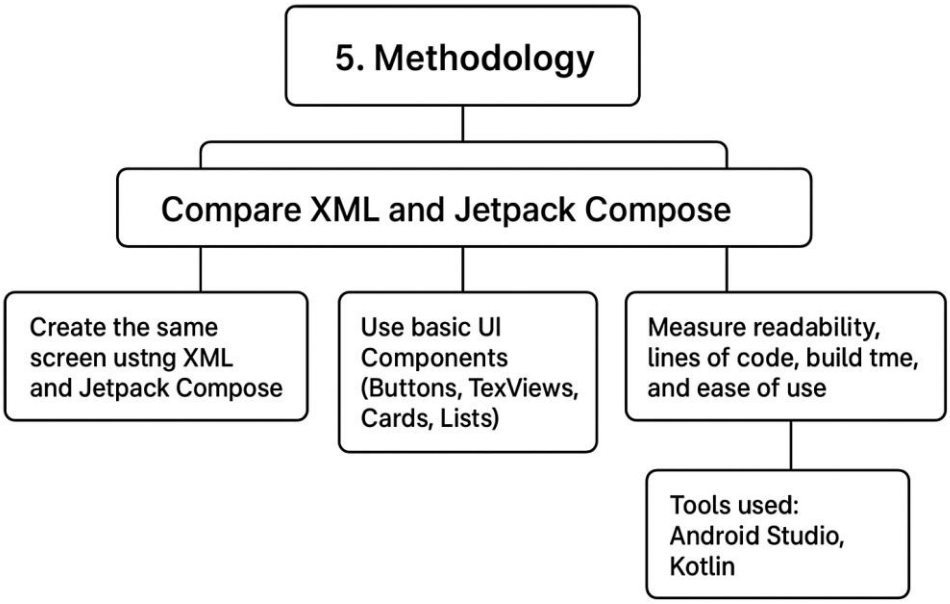
Code readability: The degree to which UI code is easy to read and maintain.

Lines of Code (LOC): The total number of lines of code used to create the tabs in each method.

Build Time: The time taken by Android Studio to build and compile the project in each implementation method.

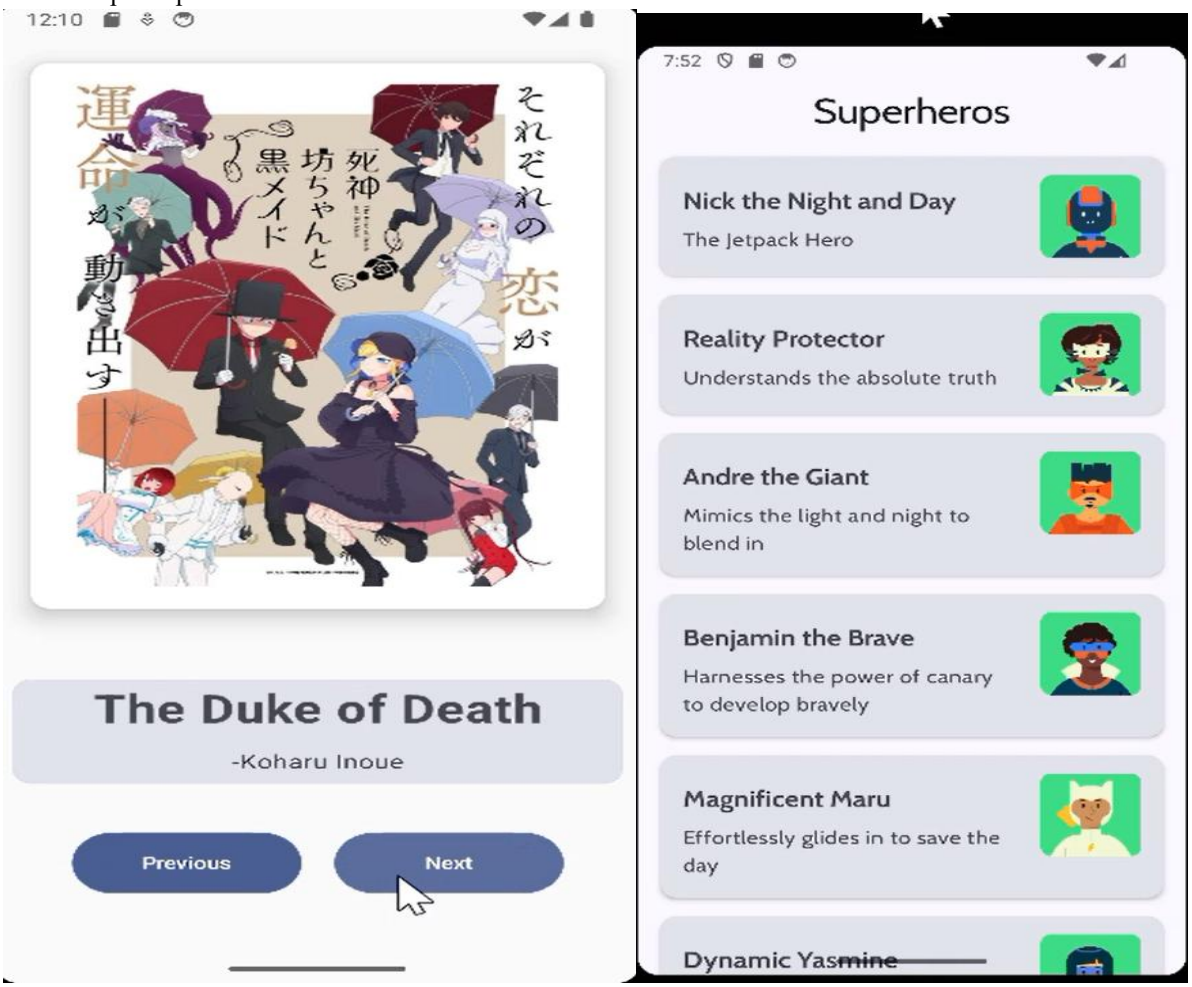
Ease of use / subjective assessment: This is based on the developers experience using each method to design and implement the UI. This includes aspects of debugging and changing and/or adding to the UI.

This implementation gave us a practical experience to be able to see a side-by-side comparison that allows us to see advantages and disadvantages of each method as they would be seen in real-life Android UI development examples.



VI. RESULTS AND DISCUSSION

We present the results based on the creation and evaluation of user interfaces using XML and Jetpack Compose. We evaluate results based on parameters that include lines of code, time to build the UI, rendering performance, and developer experience.



6.1 Length of Code

The most important difference we noticed was the code length. The code length in Jetpack Compose required far fewer lines to create the same UI. XML typically has separate layout files and custom drawable resources for UI elements, and has to be written in three separate files. For instance, a custom-styled button in XML would likely require:

A layout XML file
A drawable resource file
Kotlin logic in an Activity/Fragment

Conversely, Jetpack Compose does this in a few lines of code inside a composable function, and it does not need any external XML or drawable files.

Feature	XML	Jetpack Compose
Lines of code (per screen)	~120 lines	~60 lines
Files needed	2-3 per UI element	Single Kotlin file
Readability	Medium (depends on separating files)	High (declarative and concise)

6.2 Rendering of UI and Build Time

Although the exact UI rendering times could not be determined directly, due to constraints of the systems, Jetpack Compose provided significantly faster UI preview rendering times within the interactive preview feature of Android Studio. Therefore, Jetpack Compose took less time in updating the emulator or physical device to reflect any changes made in the UI.

Parameter	XML	Jetpack Compose
Time to build UI	Slow (due to XML parsing)	Fast (declarative execution)
Hot reload/preview updates	Slower updates	Almost instant updates

6.3 Developer Experience

From a developer standpoint, Jetpack Compose provided a more modern and consistent experience. Being able to define and preview a UI in the same file enabled faster iterations on UI. The way state is handled directly within composable functions made complex UI logic and interaction easier to work with.

That being said, XML still provides some advantages for legacy systems. Developers working in older projects or using enterprise or traditional architectures may think XML is better for reasons such as the following: its maturity and stability; documentation supporting legacy better than jetpack compose; numerous online resources and community examples; etc.

6.4 Pros of Jetpack Compose

- Less boilerplate code
- No separate XML or drawable files for custom UI elements
- Preview UI faster - build time is faster too
- Allows built-in state management
- Completely written in Kotlin - no switching between XML and Kotlin files
- Modern toolkit that will align better with Android development in the future

6.5 Pros of XML

- Mature and stable for over a decade of Android development
- Good community and plentiful documentation
- Familiar experience for many Android developers
- Better tooling for legacy APIs and design patterns
- Easier to integrate into legacy projects or codebases.

VII. CONCLUSION AND FUTURE WORK

This paper has provided a comparative examination of the two primary UI development methods for

Android: XML and Jetpack Compose. Based on our implementations and assessment of numerous important criteria, such as code length, build times, UI render times, and developer experience, we can conclude that Jetpack Compose is the future of UI development. It is a modern, concise, and maintainable way to build UIs in Android.
Jetpack Compose lessens boilerplate code, no need for separate XML or drawable files, builds and previews are faster, and state management along with Kotlin integration is naturally built-in. Jetpack Compose empowers modern Android developers with a great way to improve efficiency and development practices for new projects designed to support clean architectures and scalable products.

That being said, developers can rely on XML for existing projects built on good libraries that require backward compatibility or are developed by teams of developers from workflows of XML. XML is mature due to tooling, which means that teams with more experience use XML alongside its familiar community support resources in numerous environments.

In conclusion:
Jetpack Compose is a new, better supported and more scalable way of developing Android UIs. It is great for brand-new projects targeting maintainability and performance. But if you are continuing work on existing projects that make heavy use of legacy code and existing UI libraries, and need to maintain backwards compatibility to a specific Android version, XML will still fulfill your needs.

Future Work
To expand this comparative study, the following possibilities for future work are recommended:

- Large App Development: Examining the maintainability and performance of both approaches on challenging multi-screen apps.
- User Testing: Receiving feedback from developers with varying levels of experience about their subjective usability or learning curves.
- Performance Profiling: Measuring and comparing execution time, memory, and rendering data on real applications.

Such suggestive future directions would provide wider perspectives and help development teams choose design implementations based on project requirements.

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