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The Evolution and Impact of Linux Desktop Environments: Customization, Usability, and Their Role in Sustainable Digital Transformation

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Abstract

We live in an era of continuous upgradation and digital transformation, which drives our social, economic, and environmental ecosystem. As we are using cutting-edge technology to handle our daily life's work, we also have to consider the e-waste we produce. Most of us work with our laptop or computer, as the proprietary company gets to frequently accelerate the scale of hardware requirements to make it compatible with their services, this results in premature device replacement. To address this issue, we can turn our attention to a more efficient solution, which solves sustainability as well as the freedom of how to use it.

This paper explores the evolution of Linux desktop environments, analyzing their impact on usability, customization, and long term sustainability. By examining how these Desktop environments contribute to reducing e-waste and providing digital flexibility, our aim is to highlight their role in shaping a more sustainable technology for future generations.

Keywords

Linux, Desktop Environments, Operating System (OS), e-waste, Planned Obsolescence, Proprietary Software, Windows, MacOS, KDE Plasma, Opensource

1. Introduction

Electronic waste is a rapidly growing problem. In 2022 only, the world produced a significant amount of 62 million tonnes of e-waste [1]. This e-waste contributes to the short life span of any living creature on this earth. In this dump, a large amount of e-waste is from laptops and computers which are scraped and dropped just after a few years of usage. This is largely happening due to "Planned Obsolescence" where the major tech giants accelerate the hardware upgradation to get compatible with their software services.

This forces consumers to buy the cutting edge technology on the latest hardware which discards the existing machine and they are either thrown away or sell for less price.

2. Planned Obsolescence in Proprietary Systems

Proprietary Operating Systems often impose hardware requirements that accelerate the companies turnover. With Windows 11, for instance, Microsoft requires features (TPM 2.0, newer CPUs) that exclude PCs made just a few years ago (pre-2018) [2], [3]. One report noted **hundreds of millions of PCs** with capable specs (e.g. 16GB RAM, SSDs) are deemed "ineligible" for Windows 11 purely due to CPU generation [3].

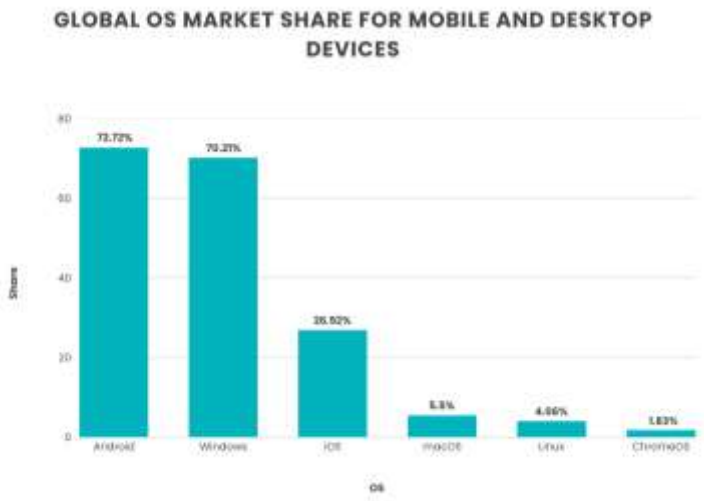

Figure 2. Global OS Market Share in 2025. *Source: Procurri, 2025 [17]*

3. Extending Hardware Lifespan with Linux

The Linux Desktop Environment is usually more resource efficient than any other OS out in the market which means they can run smoothly on old hardware [5].The Linux kernel and desktop environments are generally more resource-efficient than Windows or macOS, meaning they can run smoothly on older or lower-spec machines [5].

4. Lightweight vs. Heavyweight Desktop Environments

Linux offers a range of desktop environments, from minimalist to feature-rich. Lighter environments provide a modern user experience with far lower memory and CPU demands than the default desktops of Windows or macOS.

Desktop Environment	Approx. RAM	Characteristics & Use Case
LXQt / LXDE	~490 MB	Ultra-light, basic interface for **very old** PCs (2000s era)
XFCE	~600 MB	ideal for **old PCs** or resource-limited systems
MATE	~620 MB	Lightweight classic, good for **older hardware**
Cinnamon	~850 MB	Medium weight , familiar startmenu interface
GNOME	~1350	Heavyweight modern desktop
KDE Plasma	~1480	Feature-rich and suited for **modern hardware**

Table 6: Memory footprint of popular Linux desktop environments [5]

Figure 4: Gnome Desktop Environment [18]

Figure 5. XFCE Desktop Environment [18]

5. Comparing Linux and Proprietary Systems on Sustainability

Resource Consumption: Modern Windows and macOS have grown increasingly heavy, assuming plentiful RAM, disk, and CPU/GPU power, which pushes users of older, lower-spec machines into an upgrade. Linux, with its spectrum of desktop environments and fewer background processes, can do the same tasks with less overhead. For example, a clean install of Windows 10 might use ~4 GB RAM idle.

Software Bloat and Bloatware: Proprietary OS often come bundled with pre-installed apps, trialware, and features that tax system resources[10]. A refurbished PC with Linux comes *clean*, just the essentials the user needs. It avoids the "cruft" that accumulates on long-running Windows installations [11].

6. Adoption Challenges and Policy Recommendations for e-waste Reduction

In workplaces or schools, IT departments may be reluctant to support an OS they have less experience with. They often have contracts or ecosystems built around Windows. Additionally, as one refurbisher noted, schools teach on Windows, so *"school children are used to running Windows in school and want a computer that mirrors that experience at home [13]*. Changing this requires an institutional or a generational shift.

7. Conclusion

In conclusion, Linux desktop environments are proving to be valuable allies in the fight against electronic waste. Linux based OS challenges the notion that we must constantly upgrade hardware. As real world examples have shown, one person or a small organization switching an old computer to Linux is a small victory. Scaled up, it becomes a powerful movement for sustainability.

Reference

[1] UNITAR, **"Global e-waste Monitor 2024: Electronic Waste Rising Five Times Faster,"** 2024. [Online]. Available: https://unitar.org/about/news-stories/press/global-e-waste-monitor-2024-electronic-waste-rising-five-times-faster

[2] Technical.ly Civics, **"Windows 11 Upgrade Myth: Old PCs Still Work,"** 2021. [Online]. Available: https://technical.ly/civics/windows-11-upgrade-myth-old-pcs-still-work

[3] TechSpot, **"Report Claims Almost Half Systems Ineligible for Windows 11,"** 2021. [Online]. Available: https://www.techspot.com/news/96271-report-claims-almost-half-systems-ineligible-windows-11.html

[4] A. Fogel, **"Linux and the Sustainable Environment,"** *All Things Open*, 2022. [Online]. Available: https://allthingsopen.org/articles/linux-sustainable-environment

[5] J. Hall, **"How Linux Saves the Earth,"** *Opensource.com*, Apr. 2022. [Online]. Available: https://opensource.com/article/22/4/how-linux-saves-earth

[6] Wikipedia, **"Linux Kernel,"** 2024. [Online]. Available: https://en.wikipedia.org/wiki/Linux_kernel

[7] The Tech Edvocate, **"Linux Distros That Still Support 32-bit Architecture,"** 2021. [Online]. Available: https://www.thetechedvocate.org/linux-distros-that-still-support-32-bit-architecture/

[8] ERIC, **"Linux Adoption in Schools: Challenges and Opportunities,"** 2020. [Online]. Available: https://files.eric.ed.gov/fulltext/EJ728908.pdf

[9] Ubuntu Buzz, **"Lubuntu 17.04 Review: Lightweight and Complete Desktop OS,"** 2017. [Online]. Available: https://www.ubuntubuzz.com/2017/06/lubuntu-1704-review-lightweight-and-complete-desktop-os.html

[10] Tech Advisory, **"Windows 10 Bloatware and Their Risks,"** 2021. [Online]. Available: https://www.techadvisory.org/2021/06/windows-10-bloatware-and-their-risks/

[11] Africa PC, **"Operating Systems Overview,"** 2022. [Online]. Available: https://www.africapc.co.za/blog/operating-systems/

[12] ITS Foss, **"Is Linux Difficult for Windows Users?"** 2021. [Online]. Available: https://news.itsfoss.com/linux-difficult-easy-for-windows-user

[13] SPACE Kerala, **"Story of SPACE and IT@School,"** 2022. [Online]. Available: https://www.space-kerala.org/files/Story%20of%20SPACE%20and%20IT%40School.pdf

[14] Living Open Source, **"Why Linux is Not Just for Developers,"** 2022. [Online]. Available: https://livingopensource.org/why-its-not-just-for-developers/

[15] Interoperable Europe, **"Munich's Long History with Open Source in Public Administration,"** 2023. [Online]. Available: https://interoperable-europe.ec.europa.eu/collection/open-source-observatory-osor/document/munichs-long-history-open-source-public-administration

[16] P. Alcorn, **"Linux or Landfill? End of Windows 10 Leaves PC Charities with Tough Choice,"** *Tom's Hardware*, Oct. 2023. [Online]. Available: https://www.tomshardware.com/news/linux-or-landfill-windows-10

[17] Procurri, **"Global OS Market Share in 2025: Key Stats, Trends and Insights for Mobile and Desktop,"** 2025. [Online]. Available: https://www.procurri.com/wp-content/uploads/2025/07/1-Global-OS-Market-Share-2025-Key-Stats-Trends-and-Insights-for-Mobile-and-Desktop.png

[18] Reddit user "u/example," **"Hyprland – I wanna share a pic of my laptop,"** *Reddit*, Jul. 2024. [Online]. Available: https://www.reddit.com/r/unixporn/comments/1g2p3kd/hyprland_i_wanna_share_a_pic_of_my_laptop/