

Take It or Leave It: A Survey Study on Operating System Upgrade Practices

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Abstract

Software upgrades play a pivotal role in enhancing software performance, and are a critical component of resolving software bugs and patching security issues. However, consumers' eagerness to upgrade to the newest operating system is often tempered after release. In this paper, we focus on the upgrade perceptions and practices of users utilizing Microsoft Windows, with particular consideration given to the current upgrade cycle to Windows 10, which was, for a time, offered at no monetary cost to many users. To better understand the relevant factors for upgrade decisions, we deployed a structured survey, including several open-ended questions to add additional depth. We collected data from 239 Microsoft Windows users and utilized qualitative and quantitative methods to analyze user upgrade practices. Important themes include how to best notify users of upcoming upgrade opportunities, how users perceive privacy issues associated with OS upgrade decisions, and whether security constitutes a significant decision-making factor. We also explore how end-of-life dates, indicating the end of support by the vendor, are perceived by users.

Keywords Survey Study, Operating System Upgrades, Privacy, Security, Interdisciplinary Research

1 Introduction

Operating systems (OS), such as Windows or macOS, are used by anyone interacting with a computing device, whether this be on a desktop computer, or mobile phone. To improve OS performance and users' experiences, system engineers and researchers make design choices which cover a broad spectrum of issues including operating system interfaces, and novel feature integrations. Some of these new design choices

may be implemented in an entirely new version or *upgrade* of an operating system, or via standard operating system *updates*. While the expected individual impact of these new OS-level enhancements is (generally) positive, their overall success is dependent on the number of users who will choose to adopt them. This is particularly important in the context of security, as operating systems often perform a number of subtle actions designed to keep users secure, while they use their devices. For example in Windows 10, we are witnessing various specialized changes intended only for security, such as Virtualization-Based Security (VBS) and Windows Defender Device Guard. Enabling such security features is often contingent on upgrading an operating system. In contrast, relying on outdated OS versions may make users more vulnerable to cyber-threats [5, 26]. It is worth emphasizing that an upgraded OS often provides a platform with a more modern security architecture and, by default, the longest period of support with security updates. Upgrading in and of itself is not necessarily a security practice, but security is certainly one the factors that can influence an upgrade decision.

User upgrade behavior becomes increasingly relevant for operating systems reaching their end-of-life (EOL), which is a phase in which a company ceases to create any further updates for a given OS [4, 36]. At this point in time, users would be required to install a new iteration of an OS (e.g., Windows XP users were urged to install Windows 7) to continue receiving security updates. In 2017, an estimated 2.7% of Windows users in the United States were running operating systems that have reached EOL status [44]. If we expand this search worldwide, we find that 4.2% of computers were using computers with OSs that have reached EOL status [44]. While a number of these machines are owned and operated by consumers, a subset of these systems are also maintained and run by organizations, and form the foundation of critical pieces of infrastructure including payment processing, as well as medical and military systems [17, 25, 30]. Often, these corporations and government institutions utilize older operating systems to maintain compatibility with legacy software that has not been updated in some time, or to save on operating costs [53]. However, for consumers, the reasons for using an operating system that has reached EOL are less clear.

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Although Windows 10 is the most recent version of Windows, upwards of 48% of consumers still use Windows 7 or Windows 8 in the United States on a daily basis [44]. Mainstream support for Windows 7 ended on January 13, 2015, and mainstream support for Windows 8 ended on January 9, 2018 [36]. Extended support¹ of these operating systems will exist for several more years after these dates. More interestingly, when Windows 10 was announced, Microsoft offered the operating system as a free upgrade for any Windows 7 or Windows 8 user through July 29, 2016 [35]. During this time, the Windows 10 market share rose from 0% to 37.7% (+37.7%) by August 2016. Meanwhile, users of Windows 7 and Windows 8 declined from a combined 89.3% to 55.9% (-33.4%) [44]. While many users took advantage of this upgrade opportunity, the question of why a larger part of the user base chose not to upgrade remains relatively unstudied. In fact, besides a small-scale diary study published recently [51], we are not aware of *any* detailed work which focuses on users' upgrade practices, or which aims to understand what factors lead individuals to upgrade their operating system, or to remain on an older version.

To explore this problem, we conducted a survey study of 239 Windows users on various Windows versions, including Windows XP, Vista, 7, 8, and 10. We find that several factors including privacy concerns deterred users from upgrading to Windows 10. Users who did not upgrade believed that Windows 10 would not provide more satisfaction or usefulness compared to the OS they were currently using. We also investigated participants' perceptions about EOL, to determine whether or not this factor impacted upgrade decisions.

The rapid innovation cycle observable across different classes of devices (whether desktop, mobile, or ubiquitous in nature) increases the difficulty of identifying strategies to maintain operating systems up-to-date, which is critical to enhance the functionality and security of devices. Beyond technical requirements, it is important to understand consumers' concerns and practices regarding upgrades. Our study begins to fill the existing literature gap in this problem space and contributes to a constructive debate on the appropriate balance between several socio-technical factors.

2 Related Work

Contrary to previous works, here, we clearly differentiate between *updates* and *upgrades*. Software updates are patches released in order to address bugs, security issues, activate specific functionality, and so forth. In contrast, an upgrade is the act of replacing your (digital) product with a newer, and

ideally more superior, version of that product. Specifically, the focus of our paper is on Microsoft OS **upgrades**. While previous research on the user perspective regarding operating system *upgrades* is sparse [51], *software updates* have been investigated from different perspectives [12, 16, 18]. A third dimension to the upgrade question is under what conditions individuals are willing to *purchase a new device* (which often includes upgraded software) [48].

2.1 Software Upgrades

Most closely related to our work, Vitale et al. [51] conducted a small-scale field study with 14 technology-oriented participants who completed an OS upgrade, and were asked to take notes on the process for a period of 4 weeks in a personal diary. They found that users perceived the wait time during the upgrade process as very long, almost never mentioned security as a reason for upgrading, and had limited mental models about what was happening.

2.2 Software Updates

Several works focus on the delivery and installation of updates and patches across various devices. One of them is the struggle between automation and security challenges related to human factors [11, 42]. Mathur and Chetty [34] analyzed the issue of semi-automatic updates on Android mobile devices, and how previous user experiences impacted update behaviors. Additionally, pure update automation, alone, has been shown to be prone to failure [13]. As it is not possible or always advisable to fully perform all security (update) decisions automatically, humans remain a part of the security decision-making process, and should be proactively involved [2, 46, 54].

Vania and Rashidi [50] categorized the process(es) that users go through during software updates. In their work, they identified six stages in the update process: awareness, deciding to update, preparation, installation, troubleshooting, and post date (of the update). While useful as a broad overview, the study lacks a more in-depth analysis of user attitudes and behaviors. Following a similar path, Vania et al. [49] reported three issues that impact a user's decision to update, which include uncertainty about its (update) value, any unknown consequences, and whether or not the update is necessary.

One aspect of OS upgrades, which we focus on in this work, is how users are notified that upgrades are available. We know of no specific work in this area, though several papers address related aspects. For example, Ross et al. [8] recruited 400 participants through Amazon Mechanical Turk to analyze the emotional impact of pop-up warnings to see whether they improve or undermine decision-making. Fagan et al. [14] showed that even individuals, who indicate concern for security, will sometimes put off updating, as a result of distrust towards the party providing the update. At a higher level, user annoyance and confusion are common complaints about update notification messages. Further, Wash et al. [52]

¹According to the Microsoft Lifecycle Policy FAQ [37]: "Extended Support will be available to all customers. (Extended Support is not offered for consumer software (excluding desktop operating system software), multimedia products, online services or products governed by the Modern Policy.) Extended Support includes paid technical assistance (technical assistance that is charged on an hourly basis or per incident), security updates at no additional cost, and paid non-security updates."

studied user perceptions about computer use: what the users thought about what was happening on their computer, what they wanted to have happen, and what was actually happening during software updates. They found that a majority of users had misunderstandings about what was happening on their computers, and half of the participants were not able to execute their intentions.

2.3 Purchasing New Devices

Another way to upgrade is to purchase a new device, which often comes standard with the latest version of a given software. Tseng and Lo [48] studied survey responses of 770 Taiwanese consumers in order to find potential factors resulting in purchases of new phones, which enabled them to use a 4G network. They found that participants perceived next-generation mobile phones as easier to use and more useful than previous models, though this did not have a strong influence on their decision to upgrade or not. Furthermore, they found that when people were satisfied with their current phone model, they were not as willing to purchase a new phone [48]. We are unaware of any previous study to investigate this issue for a desktop OS. While we do not focus on this specific aspect, some of our participants refer to recent computer purchases as the key reason for now using the newest OS version.

3 Methodology

We conducted a survey study to gain deeper insights into the rationale, attitudes and perceptions of users as it relates to an operating system upgrade. Note that our focus is on the Windows OS; partly, as a means to scope the study, but also because Microsoft is the most popular OS platform. Additionally, Microsoft aggressively pushed “free” Windows 10 upgrades out to its user base for a significant period of time (something they had not previously done), adding to the intrigue of this particular upgrade path. Further, the Windows 10 upgrade, being the most recent, increased the chances of users remembering their upgrade experiences. As a result, our results are specific to the Windows platform, but also provide a foundation for further studies on other platforms.

3.1 Online Survey

A survey, our primary data collection instrument, was distributed via Amazon Mechanical Turk to users of the Windows operating system. Mechanical Turk has been shown to be a reliable platform for conducting a wide range of studies involving a diverse population, consistent with the diversity found in more traditional user studies [20, 33]. As an additional aside, while studies have explored demographic features of Mechanical Turk users in the past [38], we are unaware of any work that studies the technology capabilities of these online workers. With our survey, we were able to query participants on topics of perceived effectiveness, productivity, and satisfaction in regards to their experiences in using their Windows operating system version. In addition to

this, we also sought to understand what technical, monetary, or other factors could encourage or discourage any of our participants in upgrading their operating system (if they were using Windows 8 or an even older Windows OS), or what factors previously led the other participants to upgrade their operating system (if they were now using Windows 10).

Technology usability studies are common across many problem domains [9, 23], however, they are rarely used to analyze operating systems, and to make comparisons between these operating systems [45]. As such, the survey was designed to be comprehensive, and cover a broad range of topics. In addition, while each section of the survey presented several questions with fixed response options, we also included open-ended questions to allow participants to provide additional details about their experiences. The specifics of the measurements used are discussed in the following subsections and included in Appendix A. In constructing each of these measures, we first conducted a 50-participant pilot study to ensure proper survey design, data collection, and attribute measurement. After reviewing the results of this pilot study, we proceeded with the full study deployment. Lastly, our study was approved by the Pennsylvania State University’s Internal Review Board (IRB), which also considers ethical aspects regarding participation in research studies.

3.2 Measures

While determining *perceived usability* for various operating systems could be an admirable objective, we found this to be too broad a subject to ask our participants to evaluate. Rather, we examined components that have been deemed in the literature [40] as sub-components, or related to usability. To begin, we first chose to examine a participant’s *perceived effectiveness* when using their current operating system, based on studies which have evaluated other technologies or interfaces [15, 40]. Building on this work, we first asked our participants, using a 5-point Likert-style scale, to evaluate their perceived effectiveness when using their current operating system. For those taking our survey using any version of Windows that was not Windows 10, we asked them an identical question to determine what their perceived effectiveness would be if they would upgrade to Windows 10. This allowed us to make comparisons between perceived effectiveness on both operating systems, as a possible means to understand why participants may not have upgraded.

Continuing with scale items, we also measured *perceived productivity* [6, 47], again utilizing a 5-point, Likert-type scale. Additionally, we also measured attributes of perceived performance, and satisfaction [15]. Like our perceived effectiveness measure, participants who completed our survey using Windows 10 only received one iteration of these items. Meanwhile, participants using an older version of Windows received two sets of identical survey items: one inquiring about current experiences, and another about how these experiences might evolve if using Windows 10.

We also sought to understand what technological hurdles could affect participants in their decision-making process to upgrade, or not upgrade, their OS. To tease out these components, we asked a series of questions designed to evaluate obstacles that could exist for individuals updating their operating systems, including computer hardware age, software compatibility, installation time, risk of data loss, the monetary cost of upgrading the OS, software, or hardware, and more.

The next component of our survey dealt with the topic of the aforementioned free Windows 10 upgrade for all Windows 7 and 8 users. We asked questions detailing whether or not they were aware of this free upgrade, and what their decision process was in upgrading during this period. Additional questions in this portion of the survey focused on messaging used by Microsoft to advertise the upgrade, including pop-up messages, operating system pre-loading, and more.

Finally, we presented each of our participants with a brief paragraph explaining the nature of the EOL of an operating system. We then asked several questions to gauge how this concept may affect upgrade decisions over time.

3.3 Study Procedures

In August 2017, we recruited participants via Amazon’s Mechanical Turk platform, who were located in the United States, and had prior approval ratings of 95% or higher to ensure high data quality. Upon arriving at our survey site, and after being pre-filtered by Mechanical Turk, participants were required to read and provide their consent to participate in our study. We began the survey by asking for demographic information (age, gender, etc.) before proceeding to determine the operating system our participants were using. We obtained this information by both asking participants to provide this information, and by scanning the browser agent of each of our participants using JavaScript. The only information collected from this search was the operating system used by each participant. This was done to ensure that our participants were actually using the operating system that they claimed they were.

The survey itself took approximately 10 minutes to complete. Upon finishing the survey, participants were presented with a randomly generated code, which they were required to input back into Mechanical Turk to receive full credit for participating. The OS check, and this mandatory code entry were used to ensure participants completed the survey honestly and in its entirety, respectively. Each of our participants were compensated with \$1.00 on completion of the study.

3.4 Participants

We recruited 250 participants who used a variety of Windows OS versions. During data cleaning, 11 records were removed either due to incomplete data, or inconsistencies in participant-selected operating systems compared with detected operating systems. This left us with 239 participants.

63.60% of the participants were male, and 35.56% were female. Two of our participants did not answer this question.

The majority of the participants, i.e., 48.54%, were 25-34 years old. Of the 239 participants, 161 were using Windows 10, and 46 respondents were using Windows 7. This was followed by Windows 8 with 23 users, Windows XP with 6 users, and Windows Vista with 3 users. Table 7 in the Appendix summarizes the key characteristics of the participants.

4 Results

4.1 To Upgrade, or Not to Upgrade?

Of the 239 participants, 78 had not yet upgraded their personal computer to Windows 10 for a variety of reasons, which we attempted to capture via an open-response box at the beginning of our survey (before any priming through more detailed questions). Based on the feedback we received, we identified 18 key reasons that our participants provided as to why they did not upgrade; these are listed in Table 1. To determine the appropriate number of reasons, we use a form of qualitative non-probabilistic sampling known as *purposive sampling*. Sample size is determined by a concept called saturation, which is the point at which no additional data are being found that can develop properties of the category [19, 22]. Initially, two researchers performed the coding independently by reading all of the responses to the open-ended questions until no additional themes or categories were emerging (inductive coding). After this, these researchers discussed their codes and themes and agreed on final codes. One of the researchers used these codes to calculate the occurrence of these themes and codes across all responses. The final codes can be seen in Table 1. As a majority of the answers to the open-ended questions were succinct, we did not perform a reliability test for the final coding. In Appendix B.1, we provide for the categories, which emerged from the participants’ responses, the code names with corresponding example responses.

Based on Table 1, the most popular non-upgrade reason (48.7%) was simply that participants were satisfied with the current OS on their machine, and did not feel the pressure to upgrade by themselves. For example, one participant stated:

“P199: I have not seen any compelling reason to upgrade. I am happy with what I am currently able to do with my PC, and I really do not even see any clear advantage I have seen after upgrading from Windows 7 to Windows 8.1.”

Following this, the next most popular reasons dealt specifically with dislike of the latest operating system (19.2%).

“P44: I’ve used windows 10 on friends computers and honestly I do not like it. Windows 7 which I’m currently using is much easier to use and not as complicated as 10. I do not like it and think it is unnecessary to upgrade to it.”

Further, privacy concerns were raised by several participants, indicating that privacy issues may be considered by users when upgrading their operating system, contrary to previous findings [51]. As an example, one participant stated:

“P39: I can sum it up in 2 words: privacy concerns.”

Non-Upgrade Reasoning	Count
Satisfied with the current version	38
Do not like a new version	15
Privacy issue with Windows 10	12
Concern about upgrade process	8
Bad reviews for new version	8
Resistance to new changes and learning new OS	8
Compatibility concern (software and hardware)	7
Uncertainty about new version and bad upgrade experience	6
Upgrade when buying a new computer	5
Cost	4
Upgrade to Windows 10 then downgrade	3
Do not like push from Microsoft	3
System belongs to a company	2
Security issues of Windows 10	2
Do not have time for upgrade	1
Do not like Microsoft	1
Suspicious about free upgrade	1
Laziness and procrastination	1

Table 1. Breakdown of 78 participant responses to an open text question regarding non-upgrade decisions.

For the 161 participants, who were using Windows 10, we also attempted to capture and code their core reasonings behind their upgrade decisions via an open-response box at the beginning of the survey; see Table 2. 60.8% of them generally spoke of Windows 10 having better performance and new features, as well as having a desire to be the most up-to-date. 18.6% of participants also cited the fact that the upgrade was free to them as being the most influential aspect of their upgrade decision. We also note that 13.6% of our Windows 10 users cited *security* as being their principle reason to upgrade to the latest OS. As one participant described:

“P194: There are always security bugs that are patched with newer operating systems. Keeping an operating system that is old and no longer supported can cause issues with program compatibility. Also, I love playing and learning the newer operating systems. Seeing new features, trying newer features and seeing how it works and I can utilize it.”

While a majority of the Windows 10 users stated positive factors for upgrading their operating system, some also expressed privacy concerns:

“P4: [I upgraded] To get the most up to date features, security features, and Cortana. I hate the privacy settings though.”

Here, we have identified the primary reasons why our participants upgraded (or did not upgrade). Note that we used a neutral, open-ended question framing to receive unbiased responses from the participants. When examining the coding, a vast majority of reasons that participants provided regarding their decision to *not* upgrade their OS are likely generalizable across platforms, with some Microsoft-specific concerns (e.g., privacy issues related to Windows 10; dislike of Microsoft)

Reason for Upgrade	Count
Better (Performance, speed, stable, etc.)	36
Desire to use the newest and be up-to-date	35
Free	30
New features	27
Security	22
Come with a new computer	21
New software and hardware are compatible with new OS	19
Do not like old version	15
Push and stop notification	11
Concern about support	7
Curiosity	6
Wait till last time of free period to overcome uncertainty about new OS and bugs being resolved	5
Like Windows 10	5
Other suggestion and good reviews	5
Problem with older versions	3
Request from employer	1
Friends have the new one	1

Table 2. Breakdown of 161 participant responses regarding Windows 10 upgrade decisions.

being the exception. Similarly, the reasons provided by the participants as to why they upgraded also seem to be generalizable to other platforms as none of them are specific to Microsoft. As such, we argue that these results could provide a foundation for the evaluation of other platforms, which is an agenda item for future work.

4.2 Perceived Usefulness and Satisfaction

To construct metrics for evaluating perceived usefulness and satisfaction of OSs, we utilized previously established scale items shown to accurately measure these outcomes in the past [27]. We first conducted a reliability analysis on each scale item to ensure our results were accurately measuring the desired effects. As shown in Table 3, each of our measures were found to be very reliable for analysis, with high values for Cronbach’s Alpha.

Measure (Cronbach’s Alpha)	Scale Items
Perceived Usefulness (0.945)	-Using my OS enhances my effectiveness when using a computer -Using my OS enhances my productivity. -Using my OS improves my performance.
Customer Satisfaction (0.951)	-I am content with my OS -I am satisfied with my OS -What I get from using my OS meets what I expected for using an OS

Table 3. Comparative usability measures for the users’ OS

Figure 1 displays the perceived usability and satisfaction across participants who had upgraded to Windows 10, and those who had not. We also include a third column, which

is the perceived usability and satisfaction that participants might experience if they would upgrade to Windows 10 (this is the same group as those who had not upgraded to Windows 10). Based on this figure, both groups of participants were satisfied with their current OS, and believed their current OS to be useful. When comparing perceived usefulness and satisfaction between groups, we found that participants who did not use Windows 10 reported higher values than those who currently use Windows 10, but these differences were not statistically significant. Further, participants, who had not upgraded to Windows 10, do not believe they would experience a greater sense of usability or satisfaction if they would upgrade (see gray bars in Figure 1). In fact, the opposite is a robust significant finding (for usefulness: $t(77) = 7.465$, $p < 0.0001$; for satisfaction: $t(77) = 8.892$, $p < 0.0001$).

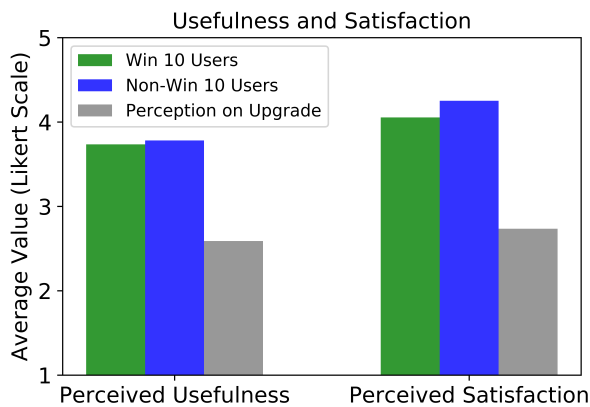


Figure 1. Comparison between users who upgraded to Windows 10 and those who did not. The third column represents the users' impressions of Windows 10 (for those who had not yet upgraded).

4.3 Measuring Upgrade Cost

We found that participants who upgraded to Windows 10 believed that the cost of upgrading their operating system was significantly less of an *obstacle* compared to the group of individuals, who had not upgraded (Mann-Whitney test, $p < 0.001$). We note here that it is possible that the actual cost for these users to upgrade could be low or high; we did not measure the internal specifications of their systems. Rather, these results are based on user *perceptions* of upgrade cost.

Concerning cost, we also sought to determine how much our participants would be willing to invest in newer hardware to support a novel OS version. 44.87% of the participants, who did not upgrade, would not pay anything at all to improve hardware; in contrast, only 27.23% of the individuals, who did upgrade, shared the same sentiment. Most of the other participants would only pay a little or a moderate amount for a needed hardware upgrade. Less than 3% would be willing

to buy a new computer (across both groups). Overall, participants, who had not upgraded, were significantly less willing to invest in hardware (Mann-Whitney test, $p = 0.002$).

4.4 Security Concerns

In the initial open-ended question, 13.66% of the participants directly attributed their upgrade decision to security concerns. For example, one participant stated:

“P62: I upgraded the OS to receive the latest security updates and because of other issues that may have been not completely fixed previously.”

Within the survey itself, we also directly asked participants to what degree they are concerned with the security of their operating system. These results are shown in Table 4.

Security Concern	Non-Win 10 Users	Win 10 Users
Not at all	2.57%	0.61%
A small amount	5.13%	4.35%
Somewhat	12.82%	11.18%
A moderate amount	26.92%	19.88%
A great deal	52.56%	63.98%

Table 4. Participants' security concerns about OS upgrades

More participants, who upgraded to Windows 10, had a great deal of concern about security. However, overall the differences between groups were not significant. Nonetheless, the high reported concern levels stand in contrast with previous findings [51], where researchers reported that participants did not actively consider security in the process of completing upgrades. Our participants, when directly queried, indicated the opposite, providing comments such as:

“P8: Security makes the most compelling reason to upgrade my operating system right now. If you're still stubbornly clomping along on an OS that's three versions or more behind the time, you're missing out on years of important security updates for your system.”

4.5 Free Upgrade and Notification Approach

Based on Table 2, one of the popular reasons that convinced many users to upgrade to Windows 10 was the fact that Microsoft provided a free upgrade period for old Windows versions (even for users without genuine Windows²). During this time period, Microsoft alerted its customers to this free upgrade using a number of notification methods. According to Table 1 and Table 2, some of customers found this notification system to be very “pushy”, which led some users to upgrade, while convincing others to not upgrade.

4.5.1 Is Free Really Free?

An interesting (significant) difference emerged when we asked participants in the two groups how much money it *would* cost them to upgrade, or how much money it *did* cost them to

²Only one of our participants mentioned the following in our pilot study: “To make my illegitimate copy a real one when upgrading to windows 10.” But none of the participants mentioned this reason in our main study. Therefore, we do not include this aspect in Table 1.

upgrade, respectively (Mann-Whitney test, $p < 0.0001$). More specifically, only 28.21% of the participants, who had not upgraded, stated that they perceived the upgrade process to be completely (monetarily) free, while 80.12% of the group, who did upgrade, considered the cost to be free.

Another factor is implicit costs such as whether an operating system upgrade likely *would* or *did* require the re-installation of custom software for the two groups, respectively. Of the group, who did not upgrade, 33.33% answered “yes”, and another 48.72% responded “maybe.” Having undergone the upgrade process reduces (as perhaps expected) uncertainty; only 5.59% of the upgraders answered “maybe.” However, somewhat worrisome, 27.95% reported that they had to indeed re-install software after the upgrade; a non-trivial percentage. The difference between groups is significant (Mann-Whitney test, $p < 0.0001$).

We received comments from several participants detailing concerns about implicit costs.

“P169: I use some very special software. I am concerned it would not be supported well. Also Windows 7 works very well. What would I gain from 10. I am not looking forward to being forced to use 10 on my next computer.”

Another participant presented an additional implicit cost, i.e., *downloading* an OS upgrade:

“P43: Usually, I tend to wait to upgrade my OS until I need a new computer or the current OS is no longer being supported by Microsoft. I dislike learning a new OS’s idiosyncracies, especially if I am currently using an OS that is very stable and has given me few problems (hate to give that up for an unknown OS that might be riddled with bugs). However, I thought about upgrading from my 8.1 to 10 when the upgrade was being offered to me for free. I stopped short because the download size was huge and I am on US Cellular 4GLTE metered internet due to being a remote, rural customer with no high-speed providers in the area. The cost of upgrading to Windows 10 was not “free” for me.”

4.5.2 Upgrade Notification System

Combining all of our participants, 71.55% of them indicated that they had received an offer for a “free” upgrade to Windows 10. Of these individuals who received these notifications, 87.13% of them stated that they definitely or likely received notifications via pop-up messages. Comments by participants showed that many were annoyed by this approach, and felt pressured to apply the upgrade. Among adopters, the following sentiments were shared:

“P184: I upgraded to windows 10 because it basically forced it. If I did not I would constantly see reminders to, and eventually from what I recall it just did it on a restart and I had no choice.”

One participant was particularly upset about how these pop-up notifications, and pressure to install the upgrade were handled, and stated:

“P169: [I did not upgrade my OS -] Not with an annoying damned thing i had to go OUT of my way to remove. Putting crap like that on someone else’s computer should be against the law or actionable

at the very least. Yeah. Some of us are still pissed about the way that was done. The forced upgrades and all ...”

4.6 Purchasing New Device

As we mentioned in Section 2.3, one of the reasons that leads to upgrading to the newest OS version is purchasing a new device with the newest version installed on it. For example, one participant, who upgraded to Windows 10, stated:

“P158: Well, I didn’t [upgrade to Windows 10]. It simply came with the machine. I would have preferred Windows 7 though.”

For users who did not upgrade to the new version, it is possible that upgrading is conditioned behavior based on buying a new device. One of our participants with Windows 7 describes their upgrade strategy as:

“P147: I usually use the old version because it’s familiar, until forced to upgrade or when replacing pc.”

5 End of Life (EOL) and Security after EOL

Particularly for the participants utilizing older operating systems, we sought to understand how much they were generally aware of the OS End of Life (EOL) process, and if this EOL had any impact on their decision to upgrade their OS. After providing an EOL definition to our participants in our survey, we asked participants whether they were aware of the concept of EOL prior to our definition, as well as if they were aware of the current EOL of the OS they were using. 53.85% of the participants who did not upgrade to Windows 10 were aware of the EOL date for their corresponding OS, while 34.62% were not aware of the concept of EOL (11.53% stated that they were unsure). For participants with Windows 10, 54.04% were aware of EOL, and 34.78% were unaware (11.18% were unsure). As such, distributions across conditions were very similar in regards to knowledge about EOL status.

Further, we asked the participants who claimed to have previously known about EOL to describe how they became aware of this concept. Table 5 describes the distribution of participants’ responses. For participants who chose “Other”, most of them assumed an EOL date for the OS that they were currently using existed, based on previous OS use. In addition, others stated that they believed EOL to be a general practice for technology products. Comments included:

“P207: I am aware of the practice in general—it was expected.”

“P152: I may have read of it online at some point, or it may have been about the ending date for Windows XP that I recall.”

EOL Discovery Method	Non-Win 10	Win 10
Email from Microsoft	7.145%	10.34%
Personal research	73.81%	70.11%
Alerts from your computer	7.145%	3.46%
Other	11.90%	16.09%

Table 5. How participants were aware of EOL

As shown in Table 5, a majority of the participants were aware of EOL based on their personal research. For those who

were unaware, one question that arises is whether OS manufacturers should state the notion of EOL to their customers more clearly. In order to capture this sentiment, we asked our participants an opinion question regarding the notion of EOL; specifically, should OS creators be required to clearly state information about a given OS's EOL, when one installs an OS or purchases a computer with a preinstalled OS? For those participants who had upgraded to Windows 10, 32.08% believed that the EOL should be stated clearly. 35.85% mentioned that the EOL notion should be *probably* stated clearly by Microsoft. 17.61% of participants were indifferent whether it should be stated or not. The rest of participants, i.e., 14.46%, did not believe that the EOL notion should have to be stated clearly. Again, the distribution of opinions between these two groups is similar.

We also explored the effect of EOL on participants' upgrade behavior. For those participants who had not upgraded to Windows 10, 25.64% mentioned that it was somewhat or extremely unlikely that they would upgrade their OS simply based on EOL. For 33.33% of these participants, the EOL issue did not have any positive or negative impact on their upgrade behavior. In contrast, 34.62% of the participants would be somewhat or extremely likely to upgrade their OS based on EOL concerns. The remainder, i.e., 6.41%, stated that they would prefer to buy a new computer, rather than worry about upgrading, if their OS reached EOL status.

For participants, using Windows 10, EOL status was a larger concern. Only 11.88% of these participants considered it to be somewhat or extremely unlikely to upgrade due to an OS's EOL status. 25.62% were indifferent. The remainder, i.e., 62.50%, would somewhat or extremely likely upgrade their OS if it had reached EOL status. It appears, participants who generally indicated a greater focus on using new OSs would be more likely to be affected by an OS reaching EOL status, and would be more motivated to upgrade. However, the difference between the two groups is not significant.

Finally, we examined our participants' perceived *fairness* of Microsoft's EOL classifications, specifically regarding Windows XP and Windows Vista and their EOL status. In doing so, we asked our participants the following question:

"How much do you agree with the following statement: Considering that Windows XP and Windows Vista have a roughly, combined, 4% market share in the United States, do you believe that it is fair that they have both reached end-of-life status, and are no longer supported by Microsoft?"

Table 6 summarizes our results with respect to this question. For those who had not upgraded to Windows 10, more than 30% believe that it is unfair for these two OSs to be no longer supported. For upgraders, this share of participants is lower. This indicates a potentially greater sensitivity to this issue by participants using older OSs, who believe that the issue of EOL will potentially impact them sooner.

Is EOL 'Fair'?	Non-Win 10 Users	Win 10 Users
Strongly disagree	12.82%	9.32%
Somewhat disagree	17.95%	12.42%
Neither agree nor disagree	24.36%	14.28%
Somewhat agree	20.51%	28.57%
Strongly agree	24.36%	35.41%

Table 6. Perceived fairness of EOL for Windows XP and Windows Vista

5.1 Security after EOL

To the best of our knowledge, this is the first study that takes into account the issue of EOL from the users' perspective. To explore this issue further, we also sought to identify how people try to keep their computer systems secure after EOL. We asked participants the following open-ended question:

"What do you believe you could do to protect your computer's security, after its end-of-life, if you could not upgrade your OS?"

To code the responses, we used a similar approach as in Section 4.1. For the participants in the two groups, the emerging themes were similar.

• **Out-of-date systems are believed to not be threatened by attacks:** Some participants stated that outdated systems which have a lower market share reduce the incentives for attackers to focus on these systems. For example:

"P22: Nothing necessary. Hackers do not bother with out of date systems."

"P137: Install virus/adware detecting software. You are also kind of protected naturally by the low market share of your OS. Adware/spyware tend to target specifically towards the most popular operating system and browser, exploiting a security weakness that is unique to that OS."

While critiquing this belief is out of the scope of this paper, several issues ought to be considered. Even if the market share of out-of-date systems is very low, the number of consumers with these devices is nevertheless considerable, and their value to attackers may still be high (e.g., legacy systems on government networks). Likewise, novel exploits may affect new and old OS versions at the same time.

• **Self-monitoring online behavior:** Several participants stated that carefully policing their interactions with suspicious websites, email attachments, and downloaded files can serve as adequate protection. For example:

"P46: Simply know what I'm downloading and don't go on websites that try to install things without my consent. It's really not hard to know who you're downloading from and do a little research beforehand. A virus software does not hurt but it comes down to personal responsibility when it comes to not getting malicious things on your computer."

• **Stop online activity:** Some of our participants even proposed to stop using the Internet as a more conservative step. For example:

"P75: Be diligent about my activity or completely stop using the computer for Internet purposes."

- **Anti-virus and anti-malware:** The most common solution approach concerned the use of these technologies; for example:

“P43: Definitely make sure that I keep a strong antivirus up to date, keep adware and malware programs functioning and up to date, and be more vigilant about how the computer is performing or any problems that I experience.”

- **Up-to-date programs and third-party patches:** By keeping your (non-OS) software current and patched, the attacker has a lower attack surface. But the user still needs to protect the OS. Hence, a user may search for a third party that may provide security support for an out-of-date OS. For example:

“P93: Just make sure I keep all of my programs up-to-date and see if a 3rd party is offering security updates for my OS.”

Many comments addressed multiple points of the categories; for example:

“P121: Keep Anti Virus software up to date. Look for reliable third party patches made by development communities to patch known vulnerabilities.”

6 Discussion

We believe that this work represents important steps in understanding the perceptions of users about OS upgrade decisions including the perceived hurdles for system upgrades. We now present the emerging themes and practical design recommendations based on our study, augmented by additional comments from the participants.

6.1 Better Communication to Address Privacy Concerns

Consumers frequently struggle with making meaningful privacy decisions [1]. For example, it has long been documented that while individuals say they value privacy, their actions in many practical scenarios often suggest the opposite, spawning a series of works on the “privacy paradox” [28, 43].

Participants frequently reported privacy concerns about upgrading their OS, which in some cases could be directly attributed as their reason for not upgrading. Other participants suggested that they underwent a deliberation process (i.e., privacy calculus) weighing privacy concerns with other factors, such as any enhanced security associated with a new OS [10]. Referencing an earlier quote, one participant, who upgraded to Windows 10, weighed potential privacy implications, and ultimately weighed newer features as more important:

“P4: [I upgraded] to get the most up to date features, security features, and cortana. I hate the privacy settings though.”

Another participant, who did not upgrade, had the opposite opinion:

“P166: I believe it [my computer] would be inherently safer [on an outdated OS] solely due to the privacy issues related to Windows 10. I could disable all safety measures and feel safer with 8.1.”

One potential reason for this mistrust is that when Windows 10 was released, numerous popular consumer-oriented technical websites, including PCWorld, CNET, and more,

issued a sizable number of articles with headlines such as ‘How to reclaim your privacy in Windows 10, piece by piece’, [3, 21, 31, 39]. Articles like this, among many others, claimed that Windows 10 was inherently designed to infringe on user’s privacy, and it appears that such reporting gained traction among Windows users. As one of our participants stated:

“P39: You know it has to be pretty bad when you’re seeing all sorts of (legit) programs and guides that are supposed to be able to help users get rid of most of the spyware. From what I’ve heard they even rolled out several updates aimed at windows 8 that were questionable (when it comes to privacy), I avoided those too.”

This participant also commented being unsure about the validity of the publicly discussed privacy issues, but would still be hesitant to install Windows 10 as a result:

“P39: I’d switch to something other than windows before I’d upgrade to windows 10. I know a lot of the privacy scares related to the OS aren’t true, but I’m still not willing to trust it.”

From a consumer-protection perspective, it is important to be explicit when describing privacy features and settings of an OS, though doing so without overwhelming users with privacy settings can be challenging [29]. Novel features (such as voice assistants) and business models driven by user data place an additional burden on consumers.

In future work, it would be important to more closely explore how privacy issues are communicated and which options are provided (in advance of and) during the Windows OS installation and configuration process. We are unaware of any research focusing on this aspect. As a result, it would be good for a vendor to provide justification about these data collection practices that lead some (both in our study and generally) to not upgrade their OS due to privacy concerns. Further, a vendor could also allow their users to customize meaningful and well-explained privacy settings. This would give users the ability to customize their OSs based on valuations of their own privacy, and potential trade-offs with performance.

6.2 Better Upgrade Messaging

Windows 10 was initially offered as a free upgrade for a limited time. While previous research has shown that free upgrades may not instill the most trust among users to begin with [32], participants also commented on the annoyance that they felt regarding how upgrade notifications were *presented* to them. Specifically, the aggressive use of pop-ups (an example of which is shown in Figure 2) and pre-downloads of the Windows 10 upgrade raised concerns among our participants.

As an example, one participant (in the pilot study) stated: *“I felt that their free upgrade notifications were very forced and were very annoying. It really turned me off from wanting to upgrade.”*

Automating upgrade steps (e.g., by pre-downloading the package) or even automatically initiating the upgrade installation irritate many users, since upgrades change many fundamental aspects of the user experience (in contrast to minor security patches). Likewise, it would be sensible to bundle upgrade messaging with other system messages, e.g., for

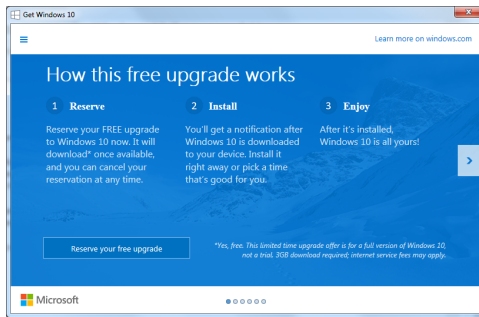


Figure 2. Example of Windows 10 Upgrade Pop-up

monthly security updates, to limit interruptions of the user experience and to appear in a contextually appropriate fashion. We further found that aggressive upgrade notifications may have pushed users to remove such notifications. As such, we suggest that a vendor could use a hybrid approach, using a balanced combination of consumer alert methods. In such a scenario, a vendor could first reduce the number of pop-up messages, which frequently annoy users. To compensate, a vendor could send emails or use social networking sites to advertise its message. Note that upgrade messaging tactics are not the focus of this work, but our participants clearly noted that this is an issue that many of them remember.

6.3 Security and the Need for a Roadmap after EOL

Contrary to previous work [51], security considerations were a common theme in our study that drove participants to upgrade their operating system. Prior to the release of Windows 10, both Microsoft and the media (perhaps, via Microsoft) proclaimed Windows 10 to be the most secure Windows operating system ever, and provided this as a major reason that consumers should upgrade [24, 41]. This method of advertising may have resonated with some participants in our study:

“P126: I always update as soon as possible, to take advantage of security patches to keep the computer as safe as possible. I also want it to run in optimal conditions.”

Therefore, one of the ways that a vendor can attract more people to upgrade is to invest in security. If this occurs, then a vendor should also invest on advertising its security features to make potential users more aware of these security enhancements.

Most of our participants educated themselves about EOL via personal research. Based on this evidence, we posit that if operating system manufacturers highlight EOL security concerns to those using older operating systems, they may be more likely to convince those individuals to upgrade their OS, or purchase a new device which would have the newer OS by default. This also allows a software manufacturer to set appropriate consumer expectations via messaging about EOL status from the beginning, without the possibility of blindsiding users later on. When reviewing the license agreements of Windows XP SP2 and Windows 8, we did not note

any explanation with respect to EOL, or its date. We believe that a vendor must specify the exact notion and date of EOL (at least, in license agreements) to satisfy consumers’ rights. Moreover, the EOL date should be communicated to a user once they upgrade to a new OS or if they buy a new computer. Notifying users about their OS’s EOL date should be a vendor’s responsibility, not consumer’s burden.

To the best of our knowledge, no formal security recommendations exist for those using OS versions that have reached EOL status (beyond upgrading). We have already seen the consequences of this in the financial and government sectors, which still rely in several cases on outdated OS versions to conduct their operations [7]. In the survey, we have identified several practices users take to protect their devices after EOL. We did not conduct an in-depth evaluation for these practices, which would be an important next step for future work to define practical guidelines for users who would not be able to upgrade for any reason.

6.4 Reduce Perceived Cost

For participants who had not upgraded to Windows 10, they perceived the cost (monetary) of upgrading to be high. Beyond the cost of the operating system itself, participants also expressed concern over having to upgrade older hardware, costing them additional money, before upgrading to the latest OS. Inversely, for those who did upgrade to Windows 10, the perceived monetary cost was very low, as was any perceived ancillary cost related to older hardware. As an initial takeaway, it is apparent that operating system manufacturers should ensure that they can distribute their operating system at a low price point (or free), while also working to support legacy hardware. If users can utilize older hardware to run newer operating systems without concerns of serious performance degradation, they will be more likely to upgrade.

In terms of implicit costs, our participants also noted concerns about potential data loss and program compatibility/license transfer that might occur during or after an operating system upgrade. One of our participants ascribed their decision not to upgrade to Windows 10 as a result of needing to back up their files first:

“P224: Its been planned for some time but I need to move a large part of data to back up. That and no specific reason to upgrade to 10 since 8.1 has worked flawless since it was originally installed.”

In this instance, the cost factor is the effort or time required to back up these files before an upgrade could take place. Concerning software compatibility costs, in terms of effort required, or potential loss from certain programs not working if they would upgrade, another participant stated the following:

“P173: I am concerned that it would cause things I have installed to no longer function properly. I have a number of legacy programs installed, some of which are 20 years old. They were difficult to set up, and I do not feel as if the changes in the newest version of Windows, which I imagine to be mostly cosmetic in nature, are worth it, for me, relative to the drawbacks they might cause for me.”

The principle takeaway from these results is that OS manufacturers should not simply consider monetary costs for consumers when advertising and deploying operating system upgrades. Rather, assurances should be made (if possible to do so) that individuals who upgrade are not at risk of losing access to programs, or even files, though both are difficult to guarantee with 100% accuracy. Regarding programs, however, it is reasonable to think that organizations could consider incorporating some form of software license or compatibility guarantee. A form of this was recently incorporated into Windows 10, in which users of this operating system no longer have to keep track of their OS product key in the event that one may need to reinstall an OS. Rather, the 'product key' is now an amalgamation of an individual's Microsoft account, and the hardware profile of their machine. Similar accommodations could be made in the area of software licensing, to assuage consumer concerns about losing software packages via an upgrade. Of course, the challenge of technical compatibility would be unaffected by such improvements.

7 Limitations

One limitation is that we only focused on Windows upgrade practices, and did not consider any other platforms and vendors. Hence, our results and analyses are *technically* specific to upgrades within the Microsoft Windows ecosystem. However, our work can be used as a foundation for studying other platforms by providing a baseline of knowledge, as many of our findings are arguably generalizable, and not necessarily specific to the Microsoft ecosystem. As a part of future work, we plan to consider different platforms and vendors and compare them with each other.

A further limitation involves the distribution of participants' operating systems. Of the 239 participants (recruited via Amazon Mechanical Turk), 161 were using Windows 10, which outnumbers all other Windows versions. Further, in our pool of data, only 9 participants (3.75%) were using an OS that had reached EOL status (and the end of extended support). However, we argue that this is consistent with the national average in the United States, and should therefore not be entirely discounted. Researching the impact of EOL is important, as many participants running Windows 7 and Windows 8 were in the midst of facing EOL concerns. Mainstream support has now ended for both versions.

A third limitation of this work was the general demographic distribution of our participants. Male participants were nearly double that of female participants, and the majority of our participants (60.67%) were younger than 35 years old. A majority of our participants (203 out of 239) had at least some college experience, and almost all of them were using either desktop or laptop. These demographics may not be entirely representative of the Microsoft Windows ecosystem, but this sample provides some understanding with respect to this ecosystem that can be generalized in future work.

Lastly, typical limitations regarding survey research such as imprecise self-reporting of past behaviors of some participants also apply to our research, however, we aimed to add robustness to our analysis by combining qualitative and quantitative analysis.

8 Conclusion

Our paper provides, what we believe, to be the first detailed study on OS upgrade decision-making from the perspective of consumers. Based on our conducted survey study, we have found that security, privacy, and explicit and non-monetary costs are prominent factors impacting the upgrade decisions of users. Specifically, we find that users are incentivized to upgrade their OS when they believe that: 1) their computer is new enough to run an OS without any issues, 2) the new OS provides the greatest level of security features, and 3) comes at low explicit and non-monetary cost. In addition, methods and the frequency of methods used to advertise OS upgrades can have an impact on upgrade adoption. Frequent pop-up messages reminding users to upgrade can have an inverse effect, and may lower the overall credibility of an organization encouraging an upgrade. In future work, with both refinements and additional factors, we aim to provide both consumers and organizations with a greater understanding of OS upgrade behaviors to ensure all users remain as up-to-date and secure as possible, and do not end up utilizing legacy operating systems which leave these individuals exposed.

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A Survey Instrument

- 1- What is your age?
- 2- What is your gender?
- 3- What is your highest level of education?
- 4- What is your annual income?
- 5- What country do you live in?
- 6- How confident are you in your computing skills?
- 7- Do you help others with their computers?
- 8- Do you receive help from others to manage your computer?
- 9- What type of computer or device is your primary computing device?
- 10- Who makes your primary laptop/desktop computer?
- 11- How old is your primary computer, to the best of your knowledge, in years old?
- 12- Are you using your primary personal computer to complete this survey?
- 13- What is the operating system on your primary personal computer?

*If Windows 10 is not chosen: Go to **Block 1***

*If Windows 10 is chosen: Go to **Block 2***

****NOTE HERE: The survey moved forward based on a combination of the participant's response, as well as reading the operating system from system string via JavaScript. The two responses (participant-provided and computer-detected) were compared to ensure a match before determining which operating system survey should be shown to the participant.**

Block 1

- 14- Open Response: Windows 10 is the most recent operating system by Microsoft, and was released in 2015. Please try to describe, briefly, why you have not upgraded your operating system. This can include anything related to the upgrade process.
- 15- Thinking about your time using Windows *x* (chosen in question 13), please respond to the following questions:
 - 15-1- Using Windows *x* enhances my effectiveness when using a computer.
 - 15-2- Using Windows *x* enhances my productivity.
 - 15-3- Using Windows *x* improves my performance.
 - 15-4- I am content with *x*
 - 15-5- I am satisfied with *x*
 - 15-6- What I get from using Windows *x* meets what I expect for using an operating system.
- 16- Thinking about Windows 10, the latest version of Windows, use the sliders below to respond to the following statements:
 - 16-1- Using Windows 10 would enhance my effectiveness when using a computer.
 - 16-2- Using Windows 10 would enhance my productivity
 - 16-3- Using Windows 10 would improve my performance.
 - 16-4- I would be content with Windows 10.
 - 16-5- I would be satisfied with Windows 10

- 16-6- What I would get from Windows 10 would meet what I expect for using an operating system
- 17- How difficult do you believe it would be to learn how to use Windows 10?
- 18- How likely would you be to upgrade your operating system if there were no obstacles to do so?
- 19- How much do you think it would cost (money) you to upgrade your operating system to Windows 10?
- 20- How do you think about each of the following items in terms of how much of an obstacle it would be as part of upgrading to Windows 10?
 - 20-1- Cost of Upgrading (Cost of software, hardware, etc.)
 - 20-2- Working with an older machine that may not be compatible
 - 20-3- Installation Time
 - 20-4- Backing up files to protect against data loss
- 21- Does your computer hardware (the computer itself) support Windows 10?
- 22- (If *no* is chosen for question 21) Would you have already upgraded to Windows 10 if your computer would support it?
- 23- How much would you be willing to pay to upgrade your hardware for an operating system upgrade?
- 24- If you would upgrade to Windows 10, do you believe you would need to re-install software from your old operating system version to the new one?
- 25- (If *yes* is chosen for question 24) What percentage of your software do you think you would have to re-install?
- 26- (If *yes* is chosen for question 24) Do you believe you would need to pay additional money to re-install any software?
- 27- How much of a concern is re-installing software for you?
- 28- How difficult, generally, do you believe it would be to install Windows 10 on your own?
- 29- Using the sliders below, please respond to what your level of concern would be for each of these potential things that could happen during an operating system upgrade
 - 29-1- Computer Rebooting Frequently
 - 29-2- The installation of an operating system fails
 - 29-3- Not being able to use the computer during an upgrade
 - 29-4- Losing information
 - 29-5- Programs don't fully work/require re-installation
- 30- How long have you used your current operating system?
- 31- Were you ever offered a free upgrade to Windows 10?
- 32- (If *yes* is chosen for question 31) How were you notified about this free upgrade?
- 33- (If *yes* is chosen for question 31) Did you ever receive pop-ups on your computer reminding you to upgrade to Windows 10?
- 34- (If *yes* is chosen for question 31) Did you trust that the Windows pop-up was genuine; that it was not a virus?
- 35- (If *yes* is chosen for question 31) Did you find the Windows 10 pop-ups to be annoying?
- 36- (If *yes* is chosen for question 31) Did you ever intend to complete the free upgrade to Windows 10?

- 37- Opinion: How would you prefer to be notified about major Windows updates?
- 38- If Microsoft would ever offer another free upgrade period to Windows 10, would you upgrade?
- 39- Did you intend to upgrade to Windows 10 during the last free upgrade period, but just forgot to do it, postponed it, or procrastinated for too long, and the upgrade window expired?
- 40- (If *yes* is chosen for question 39) Why do you think that you forgot, postponed, or procrastinated on installing the Windows 10 upgrade previously?
- 41- Have you ever upgraded your operating system before (Ex: You had Windows 2000, and then upgraded to Windows XP)?
- 42- (If *yes* is chosen for question 41) How would you describe your experience of upgrading operating systems?
- 43- (If *yes* is chosen for question 41) Did your previous operating system upgrade have an impact on your decision to not upgrade to Windows 10?
- 44- Have you ever downgraded your operating system (Ex: You had Windows 8, but removed it and install Windows 7 instead)?
- 45- (If *yes* is chosen for question 44) Which operating system did you install instead?
- 46- (If *yes* is chosen for question 44) Why did you downgrade your operating system?
- 47- Did you know (before reading it above) that your operating system had an end-of-life date, after which your operating system no longer receives any updates from Microsoft?
- 48- (If *yes* is chosen for question 47) How did you become aware of the end-of-support date for your operating system?
- 49- Does this concept of End-Of-Life for your operating system make you more likely to upgrade your operating system?
- 50- Do you believe that an operating system's end-of-life should be more clearly stated to you when you install, or purchase a computer, with an operating system?
- 51- How much do you agree with the following statement: Considering that Windows XP and Windows Vista have a roughly, combined, 4% market share in the United States, do you believe that it is fair that they have both reached end-of-life status, and are no longer supported by Microsoft?
- 52- How much do you care about the security of your operating system?
- 53- How secure do you believe your computer is, currently?
- 54- How secure do you think your computer is after its End-Of-Life date?
- 55- What do you believe you could do to protect your computer's security, after it's end-of-life, if you could not upgrade your operating system?
- 56- Do you think that updating your operating system has any impact on your privacy?
- 57- Do you have any observations/comments about the survey, or your experience with updating your operating system?

Block 2

- 58- Open Response: Please trying to describe, briefly, why you upgraded your operating system.
- 59- Thinking about your time using Windows 10, please respond to the following questions:
- 59-1- Using Windows 10 enhances my effectiveness when using a computer
- 59-2- Using Windows 10 enhances my productivity
- 59-3- Using Windows 10 improves my performance
- 59-4- I am content with Windows 10
- 59-5- I am satisfied with Windows 10
- 59-6- What I get from using Windows 10 meets what I expect for using an operating system
- 60- How difficult was it for you to learn how to use Windows 10?
- 61- How much did it cost you (money) to upgrade your operating system to Windows 10?
- 62- How do you think about each of the following items in terms of how much of an obstacle it was as part of upgrading to Windows 10?
- 62-1- Cost of Upgrading (Cost of software, hardware, etc.)
- 62-2- Working with an older machine that may not be compatible
- 62-3- Installation Time
- 62-4- Backing up files to protect against data loss
- 63- How much would you be willing to pay to upgrade your hardware for an operating system upgrade?
- 64- When upgrading to Windows 10, did you need to re-install software from your old operating system version to the new one?
- 65- (If *yes* is chosen for question 64) What percentage of your software did you have to re-install?
- 66- (If *yes* is chosen for question 64) Did you need to pay additional money to re-install any software?
- 67- How much of a concern was re-installing software for you?
- 68- How difficult, generally, was it for you to install Windows 10 on your own?
- 69- Using the sliders below, please respond to what your level of concern is for each of these potential things that could happen during an operating system upgrade:
- 69-1- Computer Rebooting Frequently
- 69-2- The installation of an operating system fails
- 69-3- Not being able to use the computer during an upgrade
- 69-4- Losing information
- 69-5- Programs don't fully work/require re-installation
- 70- How long have you used your current operating system?
- 71- Were you ever offered a free upgrade to Windows 10?
- 72- (If *yes* is chosen for question 71) How were you notified about this free upgrade?
- 73- (If *yes* is chosen for question 71) Did you ever receive pop-ups on your computer reminding you to upgrade to Windows 10?
- 74- (If *yes* is chosen for question 71) Did you trust that the Windows pop-up was genuine; that it was not a virus?

- 75- (If *yes* is chosen for question 71) Did you find the Windows 10 pop-ups to be annoying?
- 76- Opinion: How would you prefer to be notified about major Windows updates?
- 77- Have you ever downgraded your operating system (Ex: You had Windows 8, but removed it and install Windows 7 instead)?
- 78- (If *yes* is chosen for question 77) Which operating system did you install instead?
- 79- (If *yes* is chosen for question 77) Why did you downgrade your operating system?
- 80- Did you know that your operating system had an end-of-life date, after which your operating system no longer receives any updates from Microsoft?
- 81- (If *yes* is chosen for question 80) How did you become aware of the end-of-support date for your operating system?
- 82- Does this concept of End-Of-Life for your operating system make you more likely to upgrade your operating system?
- 83- Do you believe that an operating system's end-of-life should be more clearly stated to you when you install, or purchase a computer, with an operating system?
- 84- How much do you agree with the following statement: Considering that Windows XP and Windows Vista have a roughly, combined, 4% market share in the United States, do you believe that it is fair that they have both reached end-of-life status, and are no longer supported by Microsoft?
- 85- How much do you care about the security of your operating system?
- 86- How secure do you believe your computer is, currently?
- 87- How secure do you think your computer is after its End-Of-Life date?
- 88- What do you believe you could do to protect your computer's security, after it's end-of-life, if you could not upgrade your operating system?
- 89- Do you think that updating your operating system has any impact on your privacy?
- 90- Do you have any observations/comments about the survey, or your experience with updating your operating system?

B Code-book

This section includes an abbreviated form of our code book with code names and examples.

B.1 Code-book: Not Upgrade

The following codes relate to participants' responses on why they did not upgrade.

Satisfied with the current version. "P199: ... I am happy with what I am currently able to do with my PC ..."

Do not like a new version. "P44: I've used windows 10 on friends computers and honestly I do not like it. Windows 7 which I'm currently using is much easier to use and not as complicated as 10. I do not like it and think it is unnecessary to upgrade to it."

Privacy issue with Windows 10. "P166: I have serious concerns about the privacy and safety aspects of windows 10. If possible, I will never upgrade past 8.1."

Concern about upgrade process. "P156: i did not want to take the chance in messing up my computer."

Bad reviews for new version. "P151: I've heard a ton of bad reviews about it. I don't want to risk anything. I'll stick with my 8.1 for now."

Resistance to new changes and learning new OS. P236: I don't see a point to upgrade and it's complicated to get used to a new OS.

Compatibility concern (software and hardware). "P100: My computer does not have the hard drive space to complete the upgrade."

Uncertainty about new version and bad upgrade experience. "P187: I've found from experience that every time I upgrade an operating system, my computer suffers undesirable consequences that affect day-to-day use. If the upgrade doesn't crash the computer outright, it might cause it freeze inexplicably at intervals, or drain my battery so fast that the purpose of having a laptop is defeated. If an operating system is working for me, I see no compelling reason to change it, particularly given the truly adverse effects my computers have suffered over the years at the hands of so-called "upgrades"."

Upgrade when buying a new computer. "P147: I usually use the old version because it's familiar, until forced to upgrade or when replacing PC."

Cost. "P133: My computer already works fine, and I don't need to run any programs that need me to update to the new Microsoft. I also don't feel like spending money on something I don't necessarily need at this time."

Upgrade to Windows 10 then downgrade. "P50: I upgraded my system when 10 was still free and did not like it at all. My computer started having many problems, I'm assuming due to its age. I decided to revert back to 8.1."

Do not like push from Microsoft. "P239: I like my setup. And honestly I hate how it forces upgrades on you."

System belongs to a company. "P13: I would very much like to upgrade my OS, or even switch to a Mac. However, my laptop belongs to my company, and the IT department is reluctant to move quickly on any new changes."

Security issues of Windows 10. "P93: I have not upgraded to Windows 10 for one reason. I do not trust the security of Windows 10. I have read way too many stories about how there is a lot of spying that goes on in Windows 10 and how it's difficult to shut services or programs down. I want an operating system that is as secure as it can possibly be."

Do not have time for upgrade. "P208: I have not had the time to switch, and i like being comfortable with what i have on my computer. It makes the most sense to me to just use the old system."

Do not like Microsoft. "P22: ... Animosity towards Microsoft. I've never liked their corporate attitude and don't wish to give them any more of my money than I have to. ..."

Suspicious about free upgrade. "P74: I was not sure what type of data they were collecting to be offering it for free. Windows 7

works so well that I didn't want to take the chance that Microsoft screwed up another operating system. They don't have a good track record in my opinion on building the best operating system with each new iteration. I'd rather stick with what I know works."

Laziness and procrastination. "P75: ... I typically hang on the previous version of OS for a while before I switch. Part of it is I'm lazy and there is ALWAYS hassle upgrading either with the OS itself or its compatibility with my programs/games."

B.2 Code-book: Upgrade

The following codes relate to participants' responses on why they did upgrade.

Better (Performance, speed, stable, etc.) "P149: I was wanting a more stable experience and was disappointed in windows 8 in general."

Desire to use the newest and be up-to-date. "P48: tend to want the newest technology which includes having the latest OS."

Free. "P18: It was free to upgrade from Windows 7 to Windows 10. ..."

New features. "P4: To get the most up to date features, security features, and Cortana. I hate the privacy settings though."

Security. "P62: I upgraded the operating system to receive the latest security updates and because of other issues that may have been not completely fixed previously."

Come with a new computer. "P54: I did not upgraded my OS, my laptop runs Windows 10 and is what came with it when I bought it. However is not my favorite. ..."

New software and hardware are compatible with new OS. "P220: Because new software doesn't work with older versions, and the older versions start to become inefficient/stop working."

Do not like old version. "P87: I did not like Windows 8. I did not find myself having a good user experience with it and it was needlessly difficult to navigate at times. ..."

Push and stop notification. "P89: My Windows system told me that it had a large update and I didn't see a way not to upgrade it. I just let it upgrade in order for it to stop notifying me about Windows 10."

Concern about support. "P144: Because I just wanted to get it over with. I had used 7 and would continue to do so...but I figured support would stop at some point."

Curiosity. "P216: I upgrade my operating systems partly out of curiosity, I'm curious to see whats new and different. ..."

Wait till last time of free period to overcome uncertainty about new OS and bugs being resolved. "P2017: I initially had Windows 7 on this PC, but when 10 came out it included features I wanted. I delayed until some of the worst issues with the new Windows 10 were fixed, then ran the update. It was a free upgrade."

Like Windows 10. "P41: I hated Windows 7, which what I had. I also got a free upgrade so I figured why not. I had seen windows 10 before at a friends house and thought it was pretty nice. I like 10 way better than 7. Overall if it wasn't free I probably wouldn't have done it because the price is outrageous."

Other suggestion and good reviews. "P99: Because I like trying out the latest technology and I heard positive reviews."

Problem with older versions. "P42: I upgraded my operating system because the projects and reports I was generating were slow and time consuming on the last system."

Request from employer. "P36: I use my computer primarily for my work and my employer. The OS upgrade I most recently did was requested by my employer to work with some of our newer programs. Otherwise I probably would not have done a recent upgrade."

Friends have the new one. "P146: I like my systems to be up to date because I believe newer systems are more efficient. There was a lot of information about the new system and I really wanted to try it out like all of my friends. There seemed little risk to try it."

Income		Gender		Education		OS	
Less than \$10,000	17	Male	152	High school and less	36	Windows XP	6
\$10,000 - \$19,999	22	Female	85	Some college	57	Windows Vista	3
\$20,000 - \$29,999	43	No answer	2	2 years degree	27	Windows 7	46
\$30,000 - \$39,999	44	Age		4 years degree	100	Windows 8	23
\$40,000 - \$49,999	35	18 - 24	29	Professional degree	18	Windows 10	161
\$50,000 - \$59,999	22	25 - 34	116	Doctorate	1	Computer Type	
\$60,000 - \$69,999	19	35 - 44	55	Age of Computer		Desktop	139
\$70,000 - \$79,999	13	45 - 54	21	Less than a year	41	Laptop	99
\$80,000 - \$89,999	6	55 - 64	14	1 - 2 years	76	Tablet	1
\$90,000 - \$99,999	4	65 - 74	4	2 - 3 years	57		
\$100,000 - \$149,999	10			3 - 4 years	29		
More than \$150,000	2			4 - 5 years	19		
No answer	2			More than 5 years	17		

Table 7. Detailed demographic information about the participants (N = 239).