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Research Article

Responding to Information System Obsolescence: Should We Upgrade or Replace?

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ABSTRACT
As information systems (IS) age, managers must determine whether to continue upgrading these systems or replace them with systems that have greater potential to offer organizational value. Given the widespread use of information systems and the challenges that IS replacement can present, understanding the forces that encourage managers to continue to upgrade existing systems is of considerable organizational importance. Hence, drawing on prior work we identify factors related to the value a system brings to an organization, the degree of organizational commitment to the system, and the evolvability of the system that influence managerial upgrade decisions. Data collected via a cross-sectional survey of IS managers was analyzed using Partial Least Squares. Analysis of this data indicates that IS managers have a preference for upgrading systems that provide greater organizational value, suffer from fewer shortcomings, are more complex, less customized, and for which support is readily available.

KEYWORDS
IS Upgrades; IS Replacement; IS Discontinuance; Organizational Level Research; Survey Research

Introduction

A growing body of work has examined information systems (IS) discontinuance and replacement at both organizational and individual levels of analysis.[1,2] In related work, researchers have been actively exploring the role of information systems in the transformation of organizations and society.[3,4] While not universally the case, such transformations are often facilitated by the replacement of existing information systems. System replacements help to overcome inertial tendencies within organizations and offer the potential for organizational value that far exceeds the incremental benefits typically arising from ongoing upgrades to existing systems. In a third stream of research, considerable effort has been directed toward understanding information system maintenance efforts and the need to periodically update information systems with patches and new product versions.[5,6] This latter body of work highlights the value of system maintenance and upgrades as well as the challenges and limitations associated with such efforts. Together, all three streams of research suggest the presence of a salient and ongoing need for managers to determine whether to upgrade existing information systems or replace these systems with new ones.

Replacing existing information systems can provide organizations with significant opportunities to improve and rethink how they operate. Information system replacements also offer the promise of pursuing new business opportunities and the potential for lower operating costs. However, given the considerable cost, disruption, and risk that replacement projects present,[7] managers experience strong pressures to persist in the continued use and incremental updating of existing systems. While updating existing systems can limit the potential for organizational innovation, such efforts are typically far less disruptive and they permit the continued exploitation of existing skills and competencies. Continued use of existing systems thus reflects a general organizational tendency toward inertia and a bias toward maintaining the status quo.[8] Nevertheless, even in the face of this tendency, organizations regularly encounter circumstances that lead them to at least contemplate system replacements.[9] It is, however, not clear what leads managers to maintain a preference for system upgrades despite the significant short and long term implications of this preference. As a result, we sought to address the question of what factors induce IS decision makers to hold a preference for upgrading organizational information systems. To address this question, we constructed a research model that builds on prior work and empirically tested this model using data from a survey of senior level IS decision makers.

Our work offers a number of contributions. First, we present one of the first models to identify factors that induce a preference for IS upgrades over replacements. This contrasts with existing models that have tended to assume that organizations that fail to discontinue or replace existing systems will simply maintain the status quo. Second, we empirically test this model and thus provide empirically grounded insights to guide managers and future researchers. In particular, we find that managers express a preference for upgrading information systems that provide greater organizational value, suffer from fewer capability shortcomings, are more complex, are less customized, and for which support is readily available. Third, we demonstrate the significant role of strong organizational performance in reducing organization preferences for system upgrades. This finding suggests that IS transformation initiatives will be notably impeded in organizations with

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limited slack resources and that slack resources may not always be used effectively by IS managers. We elaborate on our work in the following discussion beginning with the development of our research hypotheses. This is followed by a presentation of our research methods and results. We then conclude with a discussion that includes implications for practice and opportunities for future research.

Research Foundations

A number of theoretical models have been posited to account for various information system end-of-life behaviors including system switching, replacement, and discontinuance. These models have, however, overwhelmingly focused on accounting for individual level decisions to either continue or discontinue the use of information systems.e.g.[10] As such, prior research has been dominated by cognitive models of individual choice such as the Technology Acceptance Model (TAM), Expectation Disconfirmation Theory (EDT), and Task-Technology Fit (TTF) Theory.e.g.[11,12] These models tend to emphasize cognitive and affective considerations of individual decision makers as they determine whether, for example, to continue using a social media service. While prior work has demonstrated that these theoretical models have notable capacity to account for individual level IS end-of-life decisions, they are somewhat limited in their capacity to account for organizational decisions given that organizational end-of-life decisions are typically influenced by a distinct and potentially broader range of factors.

At the organizational level, prior work argues that there are three key forms of IS end-of-life decisions.[9] The first of these is to completely abandon the use of a system. While possible, this type of decision is relatively rare given the up-front analysis that organizations typically undertake to ensure that only necessary, suitable systems are ever implemented. e.g.[13] More typically, organizations can opt to either upgrade an existing system to a newer version of the same system or replace it with an alternative system. Of these two decisions, time constraints and resource limitations are such that upgrade decisions tend to be the default decision.[14] Information system replacement decisions are, however, made with some degree of frequency and, as a result, prior research has put forward theory to explain these decisions. e.g.[1,15] This theory has, however, largely tended to assume that an organization must accept the status quo situation unless it replaces or discontinues the use of an existing system. As a consequence, a review of the wider body of research related to IS end-of-life decision making was undertaken to identify three broad categories of factors that can induce a preference for upgrades over replacements among IS managers. The first of these categories encompasses factors that reflect various aspects of the value that a system provides such as its usefulness and reliability. The second encompasses factors that represent varied forms of commitment that have been made to a system including financial investments in the system and efforts to integrate the system into organizational processes. The third category encompasses factors that influence the potential for a system to evolve in response to changing circumstances. This category includes the cost and availability of the many resources needed to operate and maintain information systems. Together, these three categories offer a taxonomically oriented framework for understanding managerial preferences for IS upgrades. We elaborate on this framework in the following discussion as we develop our research hypotheses (Figure 1).

System Value

Drawing on prior literature we identify three key aspects of system value that are of particular relevance to organizational information systems. The first of these is the utility that a system offers to an organization.[16] The second is the shortcomings in the functional capabilities of a system that impose constraints on the value that it can offer.[9,15] The third key aspect of value that we identify is the reliability of a system. While nonfunctional in nature, the value that even a highly useful system with very few functional limitations will deliver can be severely constrained when the system is unreliable.

Usefulness

Usefulness represents the utilitarian value or benefit that an information system delivers to an individual or organization. The importance of usefulness to the initial and ongoing use of information systems by individuals has thus been widely established.[16] Given competitive and other business pressures, it can be expected that system utility is also of notable importance to the persistent use of organizational information systems. Organizational resources are typically constrained and it is, therefore, essential that they only be directed toward maintaining and using systems that deliver value.[14] In addition, while initial IS use might be partly driven by fads, irrational exuberance, and normative pressures, there is far less uncertainty surrounding the utility of a system during the post-adoption period.[17–19] Preference for upgrading an existing system is, as such, far more likely to be driven by reasoned consideration of evidence, accumulated through experience, which indicates that the system is useful.[17,20] Furthermore, continued use of a system is more likely to occur when positive expectations related to its utility are confirmed through use.[21,22] This confirmation of expectations triggers user satisfaction that reduces the willingness of users to either abandon or curtail their use of a system. While user satisfaction may not be especially salient to organizational decision makers, it is likely to inform their decisions as unsatisfied users make their views known to management. Hence, given that useful systems generate organizational value and also offer benefits to individual users, it is expected that:

> H1a: Greater system usefulness fosters a preference for information system upgrade.

Capability Shortcomings

While prior work suggests that organizations will prefer to upgrade information systems when they are useful, it is possible for an IS to be deemed useful while nonetheless suffering

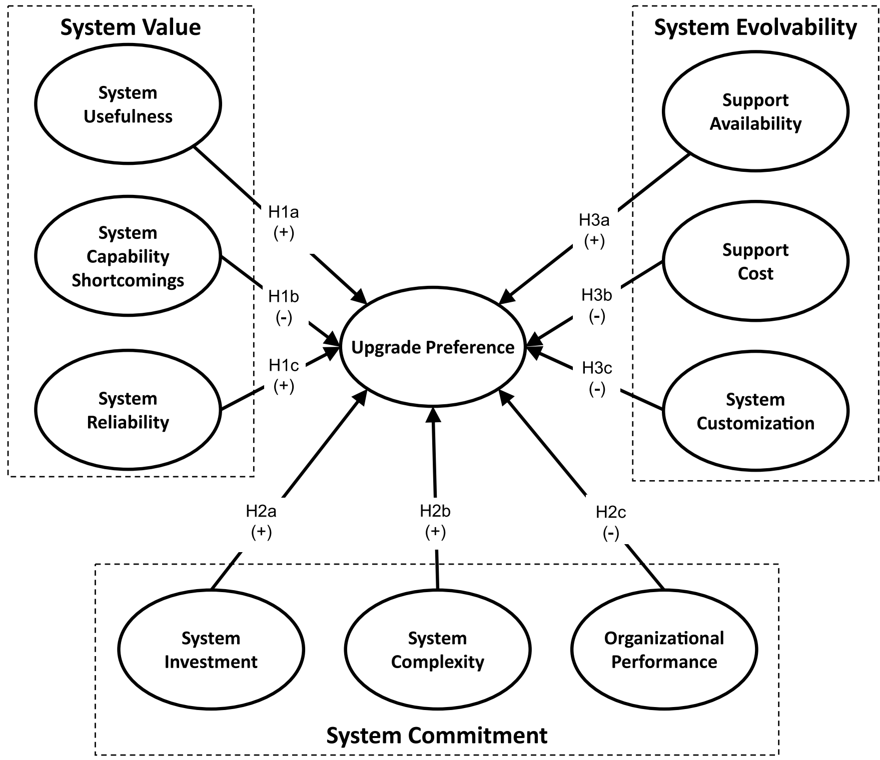

Figure 1. Research model.

from notable limitations in its functional capabilities.[9] These limitations constrain the potential value that a system is capable of offering and will, as such, undermine managerial enthusiasm for undertaking system upgrades. In addition, as shortcomings in the capabilities of a system become increasingly evident, users can become frustrated. This can lead them to devise other approaches to completing required tasks and to stop using the frustrating system to perform discretionary tasks.[23] In the long run, such reductions in system use serve to further constrain the organizational value that a system provides. Finally, satisfaction with systems that suffer from capability shortcomings is also likely to be undermined as user expectations are disconfirmed.[22] Over time, at least some users will inevitably express their frustrations and dissatisfaction to IS managers. As a result, prior work has found that system capability shortcomings can significantly increase managerial willingness to contemplate IS replacement.[9,15] Hence, in essence, it is expected that the value that a useful system provides can be overshadowed by limitations in its functional capabilities such that:

> H1b: Fewer system capability shortcomings foster a preference for information system upgrade.

Reliability

In addition to the potential for useful systems to suffer from notable functional limitations, useful systems can also suffer from sometimes severe nonfunctional limitations. In particular, since information systems generate value primarily through use,[24] the value that an organization derives from a system is notably undermined when its use is impeded by poor reliability.[25,26] System reliability, defined as "the extent to which a system can be counted upon to perform its intended tasks"[9](p.582) can thus diminish the willingness of IS managers to maintain a status quo trajectory of continued system upgrades. Managers are simply unwilling to depend on a persistently unreliable system to support key processes since this system cannot be counted upon to deliver as needed. In addition, poor reliability can notably undermine user effectiveness.[27] Hence, as with capability shortcomings, unreliable systems will encourage users to minimize system use and express dissatisfaction to IS decision makers.[22,23] Thus, as a result of the many potential issues that poor reliability poses to users and the competitive pressures that organizations face to use dependable information systems, it is expected that:

> H1c: Greater system reliability fosters a preference for information system upgrade.

System Commitment

Forces that serve to entrench or embed an information system within an organization can foster an elevated sense of commitment to the system and, as a result, some reluctance to contemplate alternatives.[1] While such commitment may be induced by a wide range of forces, three particularly salient sources of commitment can be identified from prior work. The first are the direct financial and other resources that an organization commits to the development, implementation, and ongoing operation of an information system.[9,15] In addition to these commitments, complex systems demand heightened commitment as they force organizations to develop and maintain sophisticated processes and enhanced technical competencies.[1,28] Finally, some degree of commitment is imposed on poorly performing organizations by the limits that poor performance places on the availability of the organizational resources needed to fund IS experimentation and the implementation of new systems.[29,30]

System Investment

System investment, defined as the extent to which financial and other resources have been invested in the implementation and operation of an information system, represents the financial and other direct commitments that an organization has made to a system.[9] Such investments can have significant implications for managerial decision making. In particular, unrecoverable expenses incurred by an organization will often foster escalated behavioral commitment and impede new investment.[31] Prior resource commitments have thus been found to foster behavioral persistence in numerous information system contexts despite clear evidence demonstrating the detrimental consequences of such persistence.[32,33] Given that these sunk costs can impede rationally prudent decisions, there is reason to expect that decision makers will prefer to upgrade an existing system if the system has consumed notable financial and other resources.[9] Upgrading such a system rather than proposing a replacement project avoids unfavorable attention from important stakeholders. It also minimizes the reputational damage to decision makers who have supported the existing system. Hence, given the power of reputational risk and sunk costs to reduce the willingness of decision makers to make bold changes, it is expected that:

H2a: Higher levels of investment in a system foster a preference for information system upgrade.

System Complexity

System complexity has long been regarded as an impediment to the successful completion of IS implementation projects.[34] Complexity can lead users to reject new systems and create a significant need for technical expertise to implement and then maintain these systems.[35] These challenges are compounded when a new system is intended as a replacement for an existing system that is, itself, a complex, highly integrated system. Such systems tend to exhibit a wide range of interdependencies that can severely impede replacement efforts.[1] The complexity of an existing system might thus increase managerial commitment to the system and foster a preference for upgrading it to avoid the need for a potentially daunting replacement project. Although system upgrades are not without their challenges, the risks associated with upgrades are relatively small in comparison to those arising from the implementation of a replacement to a complex system.[1,36] In addition, complex systems require more extensive changes to organizational processes and greater expertise to operate. As a consequence, organizations that operate such systems will often make notable commitments to the development of technical expertise and the creation of sophisticated business processes. Although this expertise can be readily used to facilitate upgrades to an existing system, it is typically of far less value both during and after an initiative aimed at replacing the system. Complexity is thus expected to induce heightened commitment to an existing system such that:

H2b: Greater system complexity fosters a preference for information system upgrade.

Organizational Performance

In broad terms, performance is predicated on an organization's ability to achieve its goals such that organizations that achieve their goals are generally viewed as high performing.[37] While numerous measures of organizational performance have been proposed, financially oriented assessments have been used widely and consistently.[38] Irrespective of the merits of other measures of performance, strong financial performance provides an organization with the resources that it needs to continue operating. When financial performance is particularly strong, organizational managers also develop some capacity to control and direct the use of excess or slack resources.[39] This capacity provides managers with greater latitude to undertake resource intensive initiatives including information system projects. In addition, organizations with greater financial slack experience less financial risk when undertaking such projects and they are generally better positioned to experiment with new technologies.[29,40,41] In contrast, managers at low performing organizations are more constrained in their ability to undertake risky, resource-intensive projects. Since an IS replacement project typically involves greater cost and risk than an upgrade, a certain degree of commitment to existing information systems will be induced in organizations with lower performance.[42] Finally, organizations with slack resources face some pressure to consume these resources.[43] This pressure can foster some degree of preference for resource consuming IS replacement projects among IS managers. Hence, given the limited resource slack that low performing organizations generate and the desire of high performing organizations to utilize their slack resources, it is expected that:

H2c: Lower organizational performance fosters a preference for information system upgrade.

System Evolvability

Organizational information systems that are unable to evolve in response to changing organizational needs and circumstances are at considerable risk of becoming both technically and functionally obsolete.[14,44] As such, IS managers can be expected to consider the capacity of an existing system to change and improve as needed when making an IS end-of-life decision. A system that is constrained in this regard will typically be targeted for replacement to minimize organizational dependence on a system that may prove to be both costly and difficult to change.[36] Prior work suggests three key aspects of organizational information systems that underlie their capacity for evolution. The first two are the ready availability of system support and the costs of obtaining this support.[9,15] The third is the extent to which a system has been altered or customized to align with the needs of a specific organization. Such customizations can notably impede the maintenance and enhancement efforts that drive system evolution.[45,46]

Support Availability

Availability of various forms of system support is of fundamental importance to the maintenance and continued evolution of information systems. System performance issues and functional limitations are regularly addressed through the development and implementation of system revisions and extensions.[14] Support services are also relied upon to enhance the capabilities of existing systems through ongoing adaptive and perfective maintenance activities.[47] Such enhancements can significantly increase the value that an information system delivers while simultaneously countering the threat of system obsolescence.[15,48] In contrast, when access to support is limited, organizations must accept that the functional limitations of a system and some of its performance limitations will be largely permanent in nature. Although such acceptance may not be problematic in the short term, changing organizational needs and circumstances will generally make it untenable in the long run.[49] Finally, since limited availability of system support heightens the organizational risks associated with a system failure, managers will generally seek to reduce their reliance on such systems.[50] Thus, it is expected that:

> H3a: Greater availability of system support fosters a preference for information system upgrade.

Support Cost

Support costs are the resources required for an organization to continue supporting an existing information system. Following the implementation of a system, organizations typically direct significant resources toward the ongoing support and maintenance of the system.[14,51] When the costs of supporting a system increase, the financial feasibility of maintaining the system begins to decline.[36] High support costs also diminish the benefits of upgrading an existing system relative to replacing the system. Hence, although replacing an existing system can present some significant challenges, the financial case for replacing the system becomes more compelling as support costs rise. As a consequence, many systems are eventually replaced.[36] In addition, the long-term, recurring nature of support costs is such that IS managers can face notable pressure to reduce these costs.[1,52] This can induce a preference for replacing existing systems with newer systems that are less costly to support. Finally, the continued expenditure of support resources delivers fewer benefits over time relative to the implementation of a new system that has been developed with more contemporary tools and processes.[1] As a consequence, the continued expenditure of significant resources to support an existing system delivers less value for money with the result being that these expenditures become increasingly difficult to justify. In aggregate, the implications of support costs for the relative value of system upgrades is such that:

> H3b: Lower support costs foster a preference for information system upgrade.

System Customization

System customization involves the development and implementation of information system modifications that are intended to address the needs of a specific end-user organization.[45] Customization thus moves a system away from a standardized product that can be readily maintained and enhanced through the use of commercially available support service providers, patches, and product extensions.[45,53] As a result, IS customization can notably limit the extent to which a system is capable of evolving expeditiously in response to changing needs.[53,54] In part, this is because the effort and resources needed to maintain an IS increases with increased customization.[55,56] It is, for example, often necessary to evaluate, revise, and reapply customizations when patches or updates are introduced to a system or any of its related components. As such, impediments to even modest changes can increase quite dramatically as systems are customized.[56,57] The impediments that system customization pose for system evolution are further heightened by the difficulties associated with training and retaining the expertise needed to update customized systems.[55] It is, for example, not uncommon for the departure of the personnel responsible for a customized system to impede future maintenance and upgrade efforts.[58] Finally, it can be particularly difficult to identify and address dependencies in highly customized systems.[49] This can make it difficult to identify the scope and severity of issues that might arise from updating an existing system that has been highly customized.[58] Thus, while replacing a customized system is not without its challenges, the wide range of impediments that system customization presents to the successful upgrade of an existing system suggests that:

> H3c: Less system customization fosters a preference for information system upgrade.

Methodology

Data from a cross-sectional survey of 1500 North American IS managers working in a wide range of industries was used to test our hypotheses. Survey measures were based on prior work and relied on a Likert agreement scale ranging from Strongly Disagree to Strongly Agree (Table 1). Survey respondents were randomly drawn from a widely used directory of computer executives and paper surveys were distributed via postal mail using established procedures to ensure high response rates.[59]

Table 1. Construct Measures.

Construct	Measures
Capability Shortcomings (C.S.)	The performance and functionality of this system is highly inadequate. There are notable limitations in the ability of this system to meet our needs. We would like to have many capabilities that are not supported by this system.
Organizational Performance (O.P.)	Our profitability greatly exceeds that of our competitors. We have recently experienced significant growth in our sales.* This organization significantly outperforms competing organizations.
Reliability (Rel)	People here consider this system to be reliable. This system has proven itself to be dependable. This system can be counted on to perform as needed.
Replacement Intentions (R.I.)	We plan to replace this system with a competing system. Our intention is to replace this system with an entirely different system. We will be implementing a replacement to this system.
Support Availability (S.A.)	Support for this system is readily available. We do not encounter difficulties in obtaining needed system support services. We can easily obtain the support resources necessary to continue operating this system.
Support Cost (S.Cos)	Supporting the ongoing use of this system is costly. Support costs for this system are excessive. The ongoing operational costs of this system are high.
System Complexity (S.Com)	The technical characteristics of this system make it complex. This system depends on a sophisticated integration of technology components. There is considerable technical complexity underlying this system.
System Customization (S.Cus)	This system represents a custom solution to our unique circumstances. Implementing this system involved considerable custom development and/or configuration work. This system has been tailored to meet our unique requirements.
System Investment (S.I.)	Significant organizational resources have been invested in this system. We have committed considerable time and money to the implementation and operation of this system. The financial investments that have been made in this system are substantial.
Upgrade Intentions (U.I.)	We plan to upgrade this system to a newer version of the same system. Our intention is to update this system to a newer version. Introducing a newer version of this system is part of our plan.
Usefulness (Use.)	We derive exceptional benefits from the use of this system. This system is a key contributor to the value we derive from our technology investments. Use of this system delivers extraordinary value to our organization.

Notes: All items were measured using a Likert agreement scale with values that ranged from 0 to 8. *Asterisked items were removed prior to final analysis.

The first question of the survey asked respondents whether they were responsible for IS end-of-life decisions at their organization. Those who indicated that they were not responsible for such decisions were asked to return the uncompleted survey. Those who were responsible for such decisions were asked to identify one such system and complete the survey with this system in mind. Systems reported upon were at the sole discretion of survey respondents. Respondents were not asked to focus on particular system types or on systems being targeted for upgrade or replacement to avoid sampling on our dependent variable. After three separate follow-ups to encourage responses, a total of 222 surveys were received for an effective response rate of 21.4%. Standard techniques were used to detect non-response bias with no evidence of any such bias being found.e.g.[60,61]

Analysis and Results

Our research question focused on understanding managerial preference for upgrading an existing information system rather than replacing this system with a new system. We thus constructed measures for our dependent variable by calculating pairwise differences between measures for upgrade and replacement intentions. Since our survey included three measures for upgrade intentions and three measures for replacement intentions, this resulted in a total of nine measures of upgrade preference. Prior to calculating these difference scores we reviewed our data to eliminate respondents who appeared to express inconsistent views. Specifically, we eliminated respondents who indicated that they intended to both upgrade and replace the information system that they were reporting upon. After eliminating these responses and those with missing values, our final sample consisted of 141 responses. Substantively identical results to those that we report here were, however, obtained when respondents who expressed inconsistent views were included in our analysis. The organizations included in our final sample employed an average of approximately 2000 employees with the smallest employing 50 people and the largest employing over 25,000. Approximately one third of respondent organizations were publicly listed firms. Job titles of respondents in our final sample ranged from

Table 2. Respondent Characteristics.

Gender	
Male	121
Female	20
Job Title	
Vice President	45
Director	47
Manager	35
Not Specified	14
Industry	
Banking	10
Financial Services	19
Health Care	9
Insurance	18
Manufacturing	35
Retail	47
Transportation	1
Utilities	2

Table 3. Item Cross Loadings.

	C.S.	O.P.	Rel	S.A.	S.Cos	S.Com.	S.Cus	S.I.	U.P.	Use.
CapShort1	**0.8488**	−0.0662	−0.5127	−0.5647	0.3443	−0.0635	0.1563	0.0655	−0.4548	−0.3692
CapShort2	**0.8636**	0.0350	−0.4431	−0.5166	0.3873	−0.0284	0.2571	0.1416	−0.4091	−0.3354
CapShort3	**0.8681**	0.0319	−0.3843	−0.5624	0.3551	−0.0720	0.3156	0.0931	−0.4804	−0.3116
OrgPerf1	0.0340	**0.8780**	0.0837	0.0439	0.0207	0.0540	0.2644	0.0935	−0.1142	0.0667
OrgPerf2	−0.0219	**0.9542**	0.0212	0.0583	−0.0702	0.0222	0.1997	0.0406	−0.1826	0.0278
Rel1	−0.3588	0.1163	**0.8133**	0.4221	−0.2266	0.1689	0.1140	0.0552	0.2866	0.5065
Rel2	−0.4137	0.0635	**0.8996**	0.4799	−0.2219	0.1394	0.0507	0.0775	0.4005	0.4371
Rel3	−0.5515	−0.0199	**0.9029**	0.5442	−0.1898	0.2422	0.0567	0.1624	0.4646	0.5157
SupAvail1	−0.5509	0.0450	0.4035	**0.8965**	−0.2900	0.2277	−0.2488	0.0136	0.5094	0.3744
SupAvail2	−0.5338	0.0744	0.5084	**0.8796**	−0.2432	0.1805	−0.1617	0.0095	0.4781	0.4310
SupAvail3	−0.6275	0.0374	0.5850	**0.9156**	−0.3604	0.1736	−0.1940	−0.0093	0.5673	0.4395
SupCost1	0.4008	−0.0452	−0.0766	−0.2574	**0.8647**	0.3303	0.3048	0.5163	−0.0614	−0.0470
SupCost2	0.3769	−0.0398	−0.2837	−0.3236	**0.9648**	0.2483	0.2296	0.4078	−0.1183	−0.1679
SupCost3	0.2542	−0.0982	−0.0769	−0.1298	**0.7572**	0.3685	0.2615	0.4894	0.0161	−0.0075
SysCom1	−0.1189	0.0551	0.2039	0.1938	0.2213	**0.7888**	0.3021	0.3442	0.2906	0.2626
SysCom2	−0.0742	0.0432	0.1928	0.2386	0.1617	**0.8591**	0.2713	0.4770	0.3453	0.3957
SysCom3	0.1707	−0.0680	0.0434	−0.0572	0.4394	**0.7233**	0.3846	0.5422	0.1195	0.2320
SysCust1	0.1124	0.2959	0.1716	−0.1001	0.0904	0.1725	**0.7551**	0.2647	−0.0843	0.2544
SysCust2	0.3205	0.1486	0.0249	−0.2550	0.3039	0.3983	**0.9269**	0.4418	−0.2051	0.1552
SysCust3	0.2417	0.2595	0.0738	−0.1853	0.2368	0.3299	**0.9194**	0.4242	−0.1713	0.1759
SysInv1	0.0803	0.0393	0.1319	0.0083	0.3478	0.4939	0.4134	**0.9099**	0.1556	0.3646
SysInv2	0.1130	0.0639	0.1425	0.0390	0.3717	0.4628	0.4801	**0.8425**	0.0940	0.3542
SysInv3	0.1177	0.0807	0.0190	−0.0399	0.5300	0.4238	0.2615	**0.8188**	0.0909	0.1535
UpPref1	−0.5156	−0.1737	0.4070	0.5617	−0.1242	0.3127	−0.2372	0.0987	**0.9720**	0.4541
UpPref2	−0.4918	−0.2017	0.4053	0.5461	−0.1058	0.2993	−0.1678	0.1319	**0.9642**	0.5010
UpPref3	−0.4538	−0.1670	0.4467	0.5245	−0.0984	0.3096	−0.1439	0.1808	**0.9393**	0.4783
UpPref4	−0.5263	−0.1437	0.4294	0.5758	−0.1378	0.3387	−0.2502	0.0891	**0.9698**	0.4558
UpPref5	−0.5135	−0.1710	0.4362	0.5718	−0.1236	0.3331	−0.1901	0.1213	**0.9791**	0.5078
UpPref6	−0.4852	−0.1409	0.4823	0.5599	−0.1183	0.3479	−0.1701	0.1699	**0.9706**	0.4940
UpPref7	−0.5300	−0.1466	0.4166	0.5654	−0.1116	0.3749	−0.2129	0.1018	**0.9493**	0.4293
UpPref8	−0.5228	−0.1765	0.4273	0.5667	−0.0964	0.3756	−0.1508	0.1368	**0.9678**	0.4856
UpPref9	−0.4969	−0.1464	0.4776	0.5579	−0.0914	0.3936	−0.1307	0.1881	**0.9650**	0.4743
Useful1	−0.4276	0.1175	0.4788	0.5030	−0.2953	0.3427	0.1854	0.1976	0.4107	**0.8571**
Useful2	−0.2351	−0.0650	0.4352	0.3265	0.0581	0.4191	0.1169	0.4583	0.4799	**0.8352**
Useful3	−0.3709	0.0901	0.5210	0.3699	−0.1755	0.2225	0.2368	0.2141	0.3618	**0.8895**

Manager to Vice President and approximately 16.5% were female (Table 2).

Prior to hypothesis testing, all construct measures were assessed using well-established techniques.e.g.[62,63] Measurement model assessment using SmartPLS (Version 2.0.M3) identified one measure (asterisked in Table 1) that loaded on its construct at less than the widely recommended minimum value of 0.707.[63,64] This measure was excluded from subsequent analysis. All other measures loaded significantly ($p < .01$) on their intended construct and loaded higher on their intended construct than on any other construct (Table 3). Construct reliability and Cronbach's alpha values for all measures (Table 4) were also well above widely accepted minimums.[65,66] Finally, the square root of average variance extracted (AVE) for every construct was notably larger than its correlation with all other constructs and AVE values indicated that constructs accounted for more than 70% of the variance in construct measures (Table 5).

Table 4. Descriptive Statistics.

Constructs	Mean	SD	A	C.R.	VIF
Capability Shortcomings (C.S.)	3.91	1.98	0.825	0.895	2.07
Organizational Performance	5.09	1.55	0.820	0.913	1.13
Reliability	6.06	1.56	0.847	0.906	1.88
Support Availability	5.41	2.03	0.879	0.925	2.19
Support Cost	4.12	1.97	0.888	0.899	1.83
System Complexity	5.25	1.71	0.726	0.834	1.75
System Customization	4.65	2.20	0.849	0.903	1.72
System Investment	6.08	1.64	0.828	0.893	2.01
Upgrade Preference	0.93	5.48	0.991	0.992	N/A
Usefulness	5.47	1.58	0.827	0.896	1.96

Following determination of satisfactory convergent and discriminant validity, our research hypotheses were tested using PLS with bootstrapping. Analysis included a control

Table 5. Construct Correlations.

	C.S.	O.P.	Rel	S.A.	S.Cos	S.Com	S.Cus	S.I.	U.P.	Use.
C.S.	0.860									
O.P.	0.000	0.917								
Rel	−0.518*	0.049	0.873							
S.A.	−0.639*	0.057	0.559*	0.897						
S.Cos	0.420*	−0.038	−0.239	−0.335*	0.866					
S.Com	−0.065	0.037	0.214	0.215	0.282*	0.792				
S.Cus	0.284*	0.243*	0.078	−0.225	0.269*	0.371*	0.871			
S.I.	0.115	0.066	0.121	0.005	0.465*	0.538*	0.451*	0.858		
U.P.	−0.523*	−0.169	0.453*	0.580**	−0.116	0.356*	−0.191	0.140	0.964	
Use.	−0.393*	0.046	0.553*	0.463*	−0.146	0.393*	0.203*	0.352*	0.493*	0.861

Notes: *Significant at $p = 0.01$ (two-tailed). Diagonal values are square root of average variance extracted.

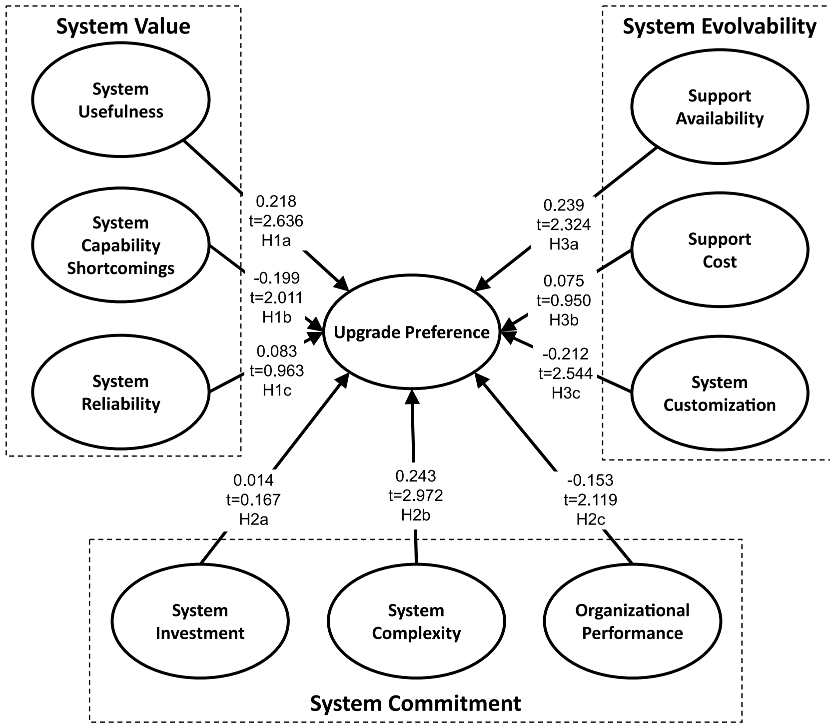

Figure 2. Structural model results.

for system age to ensure that the age of the system was not adversely influencing our results. Results of this testing provide support for six of our nine hypotheses and thereby highlight the importance of key aspects of system value, commitment, and evolvability in fostering a preference for system upgrades over replacements. Figure 2 reports path coefficients and t-values for these coefficients for all hypothesized relationships.

As Figure 2 indicates, systems that provide greater organizational value are more likely to be upgraded (H1a) while systems with significant capability shortcomings are less likely to be upgraded (H1b). In broad terms, this latter result suggests that managers would prefer to overcome functional limitations by replacing existing systems rather than attempting to address these limitations via system upgrades. However, in contrast with the results for H1a and H1b, system reliability did not have direct implications for upgrade preferences despite the assertion of H1c. In terms of system commitment, system investment was not found to contribute significantly to upgrade preference (H2a). This suggests that IS upgrade decisions are more rationally oriented and thus not notably influenced by such decision making biases as the sunk cost effect. However, system complexity does seem to foster a preference for upgrades (H2b) while greater organizational performance diminishes this preference (H2c). Finally, support availability increased upgrade preference (H3a) while support cost did not directly impact upgrade preference (H3b). System customization (H3c) reduced upgrade preference as hypothesized. In aggregate, our research model accounted for 53.4% of the variance in upgrade preference. Variance inflation factors (VIF) were calculated to assess the threat of multi-collinearity to reported results with the maximum observed VIF value of 2.19 being well below the widely accepted maximum of 5.[66] As such, we are able to offer some valuable insights into managerial preferences for system upgrades that we discuss next.

Discussion

We undertook a research initiative aimed at understanding factors that lead IS managers to prefer to upgrade existing systems over replacing them. As a basis for this effort we developed a taxonomic framework that identifies three key categories of factors that can influence such preferences among organizational decision makers. The framework that we present thus provides a foundation for understanding organizational level IS end-of-life decisions that gives explicit consideration to the possibility of avoiding the need for system replacement or discontinuance through the implementation of system upgrades. Using this framework, we developed and empirically tested nine research hypotheses by drawing on data from a large scale survey of North American information system managers. Results of this effort indicate that elements of system value, system commitment, and system evolvability all contribute to increased preference for upgrading information systems. In particular, we demonstrate that useful systems and systems that suffer from few capability shortcomings provide value that fosters a preference for upgrading these systems. This preference is also fostered by greater levels of system complexity and by weak organizational performance that both appear to create some measure of commitment to existing systems. Finally, support availability and limited system customization seem to support system evolution that fosters upgrade preferences.

The importance of the functional limitations that are evident in system capability shortcomings to IS end-of-life decision making has been demonstrated in prior work.e.g.[15] We find, however, that both system usefulness and capability shortcomings have significant implications for IS upgrade preferences. As such, our work is the first to demonstrate that capability shortcomings influence IS end-of-life decisions even when a system is deemed to be quite useful. Somewhat surprising, however, was our finding that reliability does not induce a preference for upgrading existing systems. Given the sophistication of the targeted survey respondents, we would have expected system reliability to be of considerable importance. While it might be that most contemporary information systems exhibit similar levels of reliability, the range of our data suggests otherwise. Instead, it might be the case that IS managers have comparatively little information concerning the reliability of possible replacement systems and, as a consequence, reliability has limited capacity to inform their preferences. Alternatively, it may simply be that unreliable systems are not considered to be especially useful such that the impact of reliability on upgrade preferences is indirect. In any case, there is some potential for future research in this area.

Past system investments were not found to significantly influence managerial preference for upgrading an existing system. This suggests that sunk costs may not be especially salient to IS managers or that managers may be more rationally oriented than sometimes assumed. Supporting this latter view is our finding that system complexity does seem to foster a preference for upgrades. Given the many challenges and risks associated with replacing complex information systems,[58] rationally prudent managers would be expected to prefer a trajectory of continued upgrades as long as that trajectory remains viable. This prudence would also provide some explanation for the unexpectedly long life of large systems that has been frequently reported in prior work.[36] The potential for such enduring commitment to existing systems was also evident in our finding that managers at poor performing organizations are more likely to prefer system upgrades. The lack of financial resources that this poor performance imposes can severely limit managerial latitude to undertake relatively expensive IS replacement initiatives even when these are considered important to future organizational success. On the other hand, it may also be the case that IS managers at high performing organizations are destroying some organizational value by occasionally pursuing relatively low value replacement initiatives. Future research could certainly explore this and other related possibilities in more depth.

Although greater availability of system support was found to significantly increase managerial preference for upgrading existing systems, lower support costs did not exhibit a similarly significant influence. This suggests that ongoing IS support costs are not especially salient to IS decision makers. It may, however, be the case that this finding is attributable to organizational funding allocation processes. Specifically, organizations tend to prioritize short-term goals and the achievement of set budget allocations over the achievement of long-term business strategy and value.[67] Hence, although replacing an existing system may be more financially prudent in the long run,[36] the upfront investments associated with introducing a new information system might deter replacement in organizations that suffer from capital constraints. This is supported by our finding that lower performing organizations prefer to upgrade existing systems. In addition, many organizations impose monthly or quarterly budgets that will typically motivate IS managers to confine spending to funds that have been allocated in these budgets. Since support costs are often included almost automatically in IS department budgets, managers may feel relatively little pressure to act on these costs. Instead, it may be more relevant for future work to consider whether system support costs have been subject to significant recent increases. These types of increases may place far greater pressure to act on IS managers.

Finally, we provide evidence that system customization can have significant implications for IS end-of-life decisions as suggested by conventional wisdom and by prior research indicating that IS customization impedes system upgrade efforts. One of the most significant challenges in performing enterprise software upgrades is the effort required to carry customizations through different versions.[68] Our results thus suggest that IS managers prefer to upgrade existing systems when they have not been notably customized. However, in addition to the significant direct effect that we observe, it should be noted that system customization may have more far reaching consequences. For example, customization typically increases the financial and other resources needed to implement a system and it often contributes to increased system complexity and support costs. Hence, while it was not our purpose to account for the drivers of system complexity or support costs, there would seem to be some interesting research opportunities in these domains. In any case, we provide initial evidence that system customization can negatively impact the return on investment that an information system delivers by potentially shortening its life expectancy. This possibility should be fully considered by organizations prior to committing the considerable time and resources needed to customize a system.

Implications for Practice

Our work identifies a number of factors that influence managerial preferences for information system upgrades and empirically demonstrates the significance of these factors in influencing the views of a broad spectrum of senior IS managers from a wide range of industries. As such, it offers numerous implications for system developers and for managers working at end-user organizations. In general terms, we highlight the potential importance of any action or initiative that fosters system commitment and evolvability to those developers seeking to ensure that their end-users continue to upgrade established systems. Our findings can thus be used as part of broad-based efforts to discourage customers from defecting to competing systems. They can also be used by developers to encourage their customers to regularly update systems as a means to minimize the number of product versions that must be supported. Given the costs that developers incur to support multiple product versions, such insights are of considerable value. In addition, our identification of customization as an inhibitor of system upgrades suggests that developer and end-user organizations should make additional efforts to understand the long term implications of proposed customizations before proceeding with such projects. As our work also indicates, these implications include the significant, ongoing costs associated with the maintenance of customized systems and the potential for reduced system lifespans.

The negative influence of organizational performance on upgrade preference is also of some notable practical significance. Prior work has emphasized the need to leverage and extend IS resources to operate competitively and to sustain this competitiveness in the long run.[69] However, our work draws attention to a positive feedback loop in which higher organizational performance results in greater IS investment that could, in turn, generate better organizational performance in the future. As a consequence, there may be some value in forcing IS managers to deliberately contemplate IS replacement initiatives on a regular basis. On the other hand, some care is warranted to ensure that replacement cycles are not being needlessly accelerated by the presence of slack resources. Doing so could dramatically reduce the value derived from past IS investments and potentially undermine the business cases that were made for these investments. Nevertheless, organizations seeking to initiate IS supported organizational transformations should be aware of an inherent bias against system replacements in low performing organizations. Finally, identification of support availability as a factor that strongly increases upgrade preferences suggests the presence of notable opportunities for vendors to further explore how their products, services, and support offerings can be altered to enhance system evolvability. Such efforts can encourage customers to upgrade systems rather than purchase replacements from competitors. More fundamentally, exploring opportunities to enhance evolvability can provide vendors with important mechanisms for developing and maintaining long term commitment to their products and services. The value of these efforts can be considerable given that customer acquisition and retention are essential to creating business value and long-term success.[70]

Limitations

As with any research, the work that we report is not without limitations. First, as a survey study there is some potential for various forms of response bias to impact our results. Although we took several steps to ensure that such biases were not adversely affecting our results, we believe that there are opportunities for related research that adopts alternative methodological approaches to triangulate our results. In particular, we would like to encourage more archival research in this domain. The breadth and depth of archival data that is available to information system researchers presents enormous, relatively untapped opportunities to explore IS end-of-life decision making. While not without their own limitations, we believe that archival studies can be used to triangulate our findings and offer insights that are typically very difficult to obtain via survey studies.

In addition to some of the general limitations inherent in survey studies, our final dataset included responses from only 141 respondents. While we believe that this sample is sufficient to produce important results, we would have preferred a much larger sample. A larger sample would, for example, have permitted us to examine the implications of specific system characteristics for upgrade preferences. Hence, while we believe that the general model that we present offers considerable value, we also believe that work aimed at acquiring additional insights related to system characteristics would be interesting. Finally, it was necessary to eliminate one measure of organizational performance from our analysis. Although not ideal, post hoc analysis that included this measure generated substantively identical results to those that we report. As such, we have reason to believe that elimination of this measure did not have negative implications for our work.

Future Research

Our work suggests numerous opportunities for future research that go beyond the opportunities that we have identified in the preceding discussion. First, we see some potential to identify other factors that contribute to a preference for information system upgrades. The taxonomic framework that we present can serve as a useful guide for such initiatives. For example, government regulations and industry standards or norms can heighten commitments to existing practices. Future work could thus extend our taxonomic framework to examine the impact of such regulations and standards on upgrade preferences. Further to this, given that we adopted a broad approach that included the views of a wide range of managers and many different types of information systems, there are opportunities to explore the applicability of our proposed taxonomic framework in other contexts. It might, for example, be interesting to examine upgrade preferences for specific classes of systems such as enterprise resource planning systems or business intelligence systems. It might also be interesting to examine differences across organizational and personal use contexts as well as across utilitarian and more hedonically oriented use contexts. Prior work emphasizes that evaluation of information systems is dependent on context and, as such, we expect some interesting insights from this type of work.[71]

Additionally, applying our taxonomic framework to investigate the upgrade preferences of individuals other than IS managers could offer useful insights. In many organizations, employees such as financial executives and operations managers are involved in upgrade decisions. These individuals may approach such decisions with different concerns and priorities that merit investigation. Similarly, we feel there is significant value in efforts to incorporate salient characteristics and preferences of key decision makers and additional organizational characteristics into our framework. For example, individuals and organizations both differ in their aversion to risk and such variations might influence system commitment. In addition, the notion of a system upgrade continues to evolve with technological changes. As systems become more capable and organizational dependence on information systems continues to increase, the considerations influencing upgrade preferences are likely to change. For example, system commitment may be growing as managers realize that a single system is affecting a growing portion of their operations.[72] There would thus seem to be some room to explore such possibilities in future research. In a related vein, there would also appear to be interesting opportunities to explore how consumers understand information system upgrades and what the implications of such upgrades are for consumer-oriented applications. Finally, further insight into the nature of upgrades as these relate to cloud computing environments and data analytics models could offer considerable value to organizations as they navigate an increasingly complex and volatile business environment.

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