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The legacy problem in government agencies: an exploratory study

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The Legacy Problem in Government Agencies: An Exploratory Study

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ABSTRACT

Government organizations continue to be heavily reliant on legacy systems to support their business-critical functions. When practitioners embark on legacy systems replacement projects, they tend to use the legacy software's features as business requirements for its replacement application. This unnecessarily reproduces the business processes that have often emerged from the very technical limitations of the legacy system that is being phased out – a phenomenon referred to as the "legacy problem." Public agencies are missing opportunities for innovation when they carry out legacy replacement projects in this conservative manner. Overcoming the legacy problem is "wickedly" difficult because of the complex interrelationships of information technology, organizational culture, and government agencies' normative environments. This paper reports on the use of an online survey and qualitative interviews with practitioners in government agencies to explore the legacy problem. The data revealed that public agencies tend to regard legacy system replacement projects as a distinctly technical issue, and that they do not engage in systematic practices to ensure that unnecessary carryover of the business model embedded in legacy technology does not take place. As a result, legacy feature carryover occurs frequently, because practitioners want to minimize business process changes during new system implementation. The study findings single out the procurement of Commercial Off The Shelf (COTS) software as the most common approach to the replacement of legacy systems. When COTS packages are implemented, vendors (technology providers) shape the requirements discussion and the business analysis surrounding feature selection and customization. These study findings can be instrumental when devising solutions to assist agencies in dealing with the legacy problem.

Keywords

Legacy systems, Public Sector, Requirements Engineering, Business Process Change, Risk, Innovation

1. INTRODUCTION

Legacy systems are a known challenge for the operations of modern organizations, as they limit their capacity for change and business growth [1, 2, 3]. Government agencies continue to invest substantially in legacy systems, with an estimated $35.7 billion being spent on their support in the United States federal government in 2010 [4]. Since such technologies are a financial and operational burden on government organizations, special attention should be afforded to the unique circumstances that legacy systems pose in the public sector.

Legacy systems tend to be defined primarily as software and hardware, and the approaches to their replacement focus predominately on product selection, technology integration challenges, and on the identification of data migration paths [5]. Increasingly, however, such systems are seen as an amalgam of technology, organizational practices, policies and structures [6]. Since legacy systems, due to their historical presence in the organization, become deeply rooted in an institution's thinking about how work should be organized [7], we explore and promote a similar perspective. We recognize the phasing out and replacement of legacy systems as a multidimensional, continual [8] and opaque problem area (where "opaque" is employed to signify organizational complexity – [9]), which transcends the domain of information technology.

While the number of scholarly studies and reports on legacy systems in industry and government has dwindled in the last decade, this by no means suggests that legacy systems are no longer a salient issue today. In 2013 the Comptroller and Auditor General in the United Kingdom issued a report ordered by the House of Commons entitled "Managing the risks of legacy ICT to public service delivery" [10]. The report defines legacy systems as a risk per se, and studies the financial and organizational aspects surrounding legacy systems in several agencies. Four case studies are featured, which include systems with major functions and large-scale monetary impact. The report asserts that managing legacy systems is an integral element of public service delivery, rather than a set of isolated or transitory projects focused solely on technical upgrades. It also singles out the legacy system replacement route, among several organizational approaches, as the most conducive to comprehensive organizational transformation. However, we

argue that even if legacy systems are discontinued and replaced with new applications, it does not follow that substantive, significant or improvement-inducing changes are made in the organization's business processes. Our research interest was therefore not only to reveal if legacy systems were being replaced, but to determine how their replacement was undertaken in current practice - if a technology face-lift was performed, or if opportunities for deeper business transformation were taken advantage of. How government agencies teeter between innovation and their legacy model is important to understanding how they can improve the public services to their constituents.

2. PAPER AIM AND ORGANIZATION

The purpose of this paper is to present and analyze data collected from an online survey and a set of practitioner interviews which aimed to capture key aspects of legacy system replacement projects in 30 government organizations across North America and Europe. This data collection represents the preliminary phase of a research programme intended to propose a novel approach for use by public sector professionals during the requirements stage of projects involving the replacement of legacy systems.

The paper is organized as follows. Section 3 introduces the concept of the "legacy problem" and frames it as a "wicked" organizational issue. Section 4 introduces our research approach. Section 5 describes how the survey data was collected, discusses the key findings, and argues the need for follow-up interviews. Section 6 describes the interview format, and discusses the main themes from the interviews. Section 7 provides an interpretation of both the quantitative and qualitative research data. Section 8 offers some conclusions on the overall results and directions for future research.

3. THE LEGACY PROBLEM AS A WICKED ORGANIZATIONAL PROBLEM

We have coined the term "legacy problem" to represent the phenomenon whereby, due to their embeddedness in organizational workflows, role, culture and practices, aspects of the functioning of legacy systems are uncritically replicated in the systems meant to replace them as they are perceived as operationally essential [11]. The legacy problem exhibits characteristics similar to those of the grand social problems identified by Rittel and Webber as "wicked" [12]. It is complex, variable, deep-rooted, persistent and multi-dimensional – it involves the dynamic interplay of technology, individuals and organizational structures [13] and is particularly acute in the public sector. This is due to the inherently bureaucratic nature [14] of government organizations combined with an unstructured larger operational environment [9], and their risk-averse mode of functioning, which discourages critical analysis, and promotes inertia, or "survival-based reactivity" (a term coined by T. Schwartz [15]).

The most common managerial attitude towards legacy systems treats them largely as a technology-only problem, relegated to the IT department to resolve through back-end conversions, data translations or the development of interface wrappers [5, 16], so the business side does not have to plan for or undergo any changes. In government organizations, where a large number of business-critical applications are legacy systems, the IT/business divide exemplifies a reductionist approach to

systems analysis which could lead to unsuccessful software product selection or IT project failure.

It can be argued that key aspects of the operational model of government organizations are defined by the technologies they relied on, and it is only natural that this model dictates the set of requirements for newer replacement applications. The term "legacy systems" is also used as a synonym for mainframe systems, and practitioners tend to assume that legacy problems are off their agenda once mainframe technologies are phased out. However, as researchers point out, legacy systems are not a transitory, but a continual issue: "Today's new system will become the legacy system in the next, inevitable, round of change" [8]. It is therefore a wickedly difficult task, and also one of strategic importance, to disentangle an organization's business/operational model from the technological systems that support it, in order to perform a high fidelity analysis of new system features and innovations that can be strategically beneficial for public services.

The requirements phase of legacy replacement projects is the critical junction at which unnecessary carryover of an old system's features can be addressed [17, 18]. A review of requirements engineering in government IT is therefore merited. Very few studies have been dedicated specifically to requirements practices in public agencies [19, 20]. The UK study from 2004 [19] for instance, identified a low adoption rate of formal requirements engineering methods and a superficial level of attention to the requirements phase in IT projects in government. Research into the requirements work involved in legacy technology replacement projects is also sparse; for example, there are case studies which describe reverse engineering efforts during which requirements are derived from legacy code [21]. Recommendations are made to supplement any specifications obtained in this manner with an in-depth business process review, however it is unclear whether or how these recommendations have been implemented. For this reason, we embarked on studying how government practitioners go about defining requirements to replace legacy systems and how the balancing act of preserving the core business functionality supported by the legacy system and introducing new features and processes unfolds.

4. RESEARCH APPROACH

An exploratory online survey was developed to gauge the extent of the legacy problem in quantitative terms, and to examine how government organizations are dealing with it.

The survey instrument consisted of 29 questions divided in 4 sections. The first section dealt with the scope and characteristics of the legacy problem – i.e. the problems as well as the benefits presented by maintaining legacy systems, the criticality of legacy systems, the effort dedicated to legacy system replacement, and preferred approaches to their replacement. We chose to assess the scope of the legacy problem by asking about the staff resources dedicated to projects involving legacy systems replacement. Unlike the UK Auditor's office study [10] we have not asked questions regarding the budget dedicated to legacy system maintenance, or questions about funds collected and managed with legacy systems, because respondents may not possess this knowledge, and if they do, it may not be verifiable.

The second section dealt with the impact of legacy system replacement projects on the respondents' organization – what

are the organization's primary concerns with the implementation of legacy replacement systems, what issues emerge, and what level of carry-over of features from legacy systems into new applications typically occurs. The third section was dedicated to specifics about the requirements and business analysis practices undertaken during legacy replacement projects – how these requirements are collected, and analyzed, who performs these activities, which methods and techniques are useful. The fourth section collected information about the survey respondents, the size and type of their organizations, respondents' roles and background, and other similar questions.

Semi-structured qualitative interviews were conducted as a follow-up to the survey, with the purpose of enabling practitioners to expand on the topics covered in the survey, to elaborate on the legacy problem in greater detail and in their own words. The interviews incorporated certain assumptions about legacy replacement projects in government organizations that were derived from the survey, namely that legacy-related projects are often contentious, that some form of business process change is almost always involved, whether attempts to minimize it are made or not, that external companies/consultants, service providers are actively involved and can determine the course of a project.

Despite these assumptions, the interviews followed an open-ended format which allowed the participants to communicate their stories without preconceptions or impositions of any particular theoretical view concerning the interplay of technology, individual and political factors in organizations. The interview questionnaire's design is included in Section 6.

5. ONLINE SURVEY

5.1 Survey Data Collection Procedures

The URL of the survey was disseminated via email to several distribution lists of digital government practitioners, and it was also posted on professional community groups on social networks such as LinkedIn, Google+, Facebook, etc. The cumulative reach of all these communication methods is over 1000 recipients, however it is not clear how many actually received and read the invitation to participate in the survey. It is therefore impossible to accurately determine a response rate.

36 full and 3 partial responses were received. A total of 100 users clicked on the survey link (i.e. accessed the first page which contains the description of the project and the survey). The characteristics of the respondents who completed the survey are presented in the table below.

Table 1. Characteristics of Survey Participants

Total Number of Full Responses: 36
Level of Jurisdiction of Respondent's Organization: 68.57% Local/County/City   17.14% State/Regional   14.29% Federal/National
Legacy system replacement project direct involvement   80% - Yes (currently involved)   8.57% - Yes (involved in the past)   11.43% - No – not directly involved

Respondents' Organizational Role   28.57% IT Manager   20% Business/Operations Manager   17.14% Executive Level (CEO, CIO etc.)   11.43% Other IT specialist   8.57% Business Analyst   5.71% Systems Developer   5.71% Systems Administrator   2.85% Other
Respondents' Agency Size   57.14% Over 1000 employees   34.29% 100-1000 Employees   8.57% Under 100 Employees
Respondents by Country   58.8 %   United States   23.5 %   United Kingdom   8.8 %   Canada   5.9 %   Netherlands   2.9 %   Romania   5.9 %   Unknown (no response)

In summary - 88.571% of the respondents were either currently directly involved in legacy system replacement projects, or had been involved in such projects in the past. Approximately half of the respondents were Information Technology specialists. The majority represented large government agencies. Most of them were from North America (the United States and Canada). 32.3% were from EU countries.

The responses were collected over a period of 6 months.

5.2 Survey Findings

5.2.1 Legacy problem characteristics and scope
97.57% of respondents' organizations have a business-critical legacy system. For 34% of these organizations, most or all business-critical systems are legacy systems.

Table 2. Organization's reliance on legacy systems

All business-critical systems are legacy systems	2.44%
Most business-critical systems are legacy systems	21.95%
Some business-critical systems are legacy systems	53.66%
A few business-critical systems are legacy systems	19.51%
No business-critical systems are legacy systems	2.44%

Approximately 64% of respondents indicated a moderate-to-large extent of effort (represented as number of staff members involved in dedicate projects) to replace legacy systems.

Table 3. Extent of organizational effort to replace its legacy systems

A large number of staff, and/or large budget	24.32%
A moderate number of staff, and/or moderate budget	40.54%
A small number of staff, and/or budget	24.32%
No effort is currently taking place	10.81%

In terms of impact to their organizations, respondents highlighted the inability to accommodate new business needs, limited integration capabilities and high maintenance costs as

the top three issues resulting from the reliance on legacy systems.

Table 4. Issues that may result from the reliance on legacy systems

	High Impact	Very High Impact
Inability to accommodate new business needs	43.90%	26.83%
Limited Integration Capabilities	43.90%	26.83%
Maintenance costs	41.46%	17.07%

In terms of benefits from legacy systems, respondents ranked high staff familiarity and system reliability as the highest for their organizations. However, most respondents indicated that such benefits have a low impact.

Table 5. Benefits from reliance on legacy systems

	High Impact	Very High Impact
High staff familiarity with the system	25.64%	15.38%
System reliability	33.33%	10.26%

Several survey respondents completed the comments section of this question. Some of them conveyed that legacy systems introduced issues with over-reliance on a small number of employees with knowledge of the legacy system (employees who might also be near retirement age), others - that such systems cannot be used efficiently in a distributed manner, that data exchange and interfaces with other application require manual efforts. A respondent also noted specifically that the costs of identifying, documenting and re-coding the business rules embedded in legacy systems are extensive.

5.2.2 Legacy replacement work and feature carryover

The majority of respondents indicated that they implement COTS to replace legacy systems often or in some cases always.

Table 6. Preferred approach to legacy systems replacement in the organization

	Always	Often	Sometimes	Rarely	Never
COTS	8.1%	62.2%	27.0%	2.7%	0.0%
SAAS	5.7%	22.9%	37.1%	31.4%	2.9%
In-house development	2.8%	22.2%	27.8%	33.3%	13.9%
Outsourced development	5.6%	19.4%	22.2%	44.4%	8.3%

In terms of the impact of legacy replacement projects to their organizations' operations, respondents indicated that such projects introduce (in order of magnitude of impact) – 1) changes to operational procedures, 2) the need to train or –re-train staff, 3) organizational policy changes.

Table 7. Wider business impact of legacy replacement projects

	Very High Impact	High Impact	Moderate Impact	Low Impact
Changes to Operational Procedures	19.4%	61.1%	16.7%	2.8%
(Re-)Training of Staff	30.6%	36.1%	25%	8.3%
Organizational Policy Changes	11.4%	37.1%	45.7%	5.7%
Changes to Staffing Levels	8.3%	33.3%	22.2%	33.3%
New Organizational Roles	2.8%	30.6%	50%	13.9%

Other issues respondents' organizations were concerned with during legacy system replacement projects include reduced resource levels available to support new systems, technical integration challenges, lack of knowledge about new technologies, lack of knowledge about business rules in the organization, and the lack of transparency in project-related communication.

Over 42% of responses indicated that a lot, or almost all of legacy system features carry over into the new replacement system.

Table 8. the level of carryover of features from legacy systems into the new applications that replace them

Almost all legacy features carry over	5.71%
A lot of legacy features carry over	37.14%
Some legacy features carry over	37.14%
A few legacy features carry over	11.43%
No legacy features carry over	8.57%

The reasons for feature carryover from old-to-new replacement systems according to respondents are (in order of frequency of occurrence): 1) the desire to minimize changes, 2) end-user habit, 3) legislative and policy mandates.

Table 9. Reasons for legacy system features carry over into new application(s)

	Always	Often	Sometimes	Rarely
To minimize changes to business operations	5.6%	58.3%	25%	5.6%
Mandated by policies or legislation	16.7%	41.7%	30.6%	8.3%
Because end-users are accustomed to them	11.1%	47.2%	19.4%	13.9%
Because they have been stable for years	5.6%	22.2%	47.2%	16.7%
Because tech. specifications for them are readily available	5.6%	22.2%	25%	33.3%

Respondents cited several additional reasons for feature carryover, which were not listed as response options in the survey, and these include software/hardware requirements, emotional investment on behalf of users and administrators, integration requirements and dependencies on other systems, and data continuity concerns.

5.2.3 Requirements practices utilized in legacy replacement projects

Although our focus is not to detail out the diversity of requirements engineering practices and methods employed in government agencies, we were interested in exploring whether the replacement of legacy systems was approached differently than other types of information technology projects in terms of requirements gathering. Since there haven't been any comprehensive recent studies on requirements practices in government IT since 2004 [19], we have no definitive comparative basis to use to juxtapose the requirements approaches taken for legacy replacement projects to those for the procurement and development of systems without predecessors. With this in mind, we framed the question in terms of requirements "sources," in order to more specifically evaluate the potential carryover from legacy systems.

The three most useful sources of requirements in order of ranking by respondents were: 1) interviews with business users, 2) technical documentation and 3) interviews with IT staff.

Table 9. Sources of business requirements for the new applications/services replacing legacy systems.

	Most Useful	Very useful	Somewhat Useful	Barely Useful	Not Useful
Interviews w/ business users	27.8%	52.8%	16.7%	0.0%	0.0%
Technical documentation of existing/ previous system	5.6%	47.2%	25.0%	5.6%	5.6%
Interviews w/ IT staff	8.3%	41.7%	41.7%	0.0%	5.6%
Focus Groups	5.6%	33.3%	27.8%	13.9%	5.6%
Surveys of End Users	16.7%	19.4%	27.8%	22.2%	2.8%
Studies by consultants/other orgs	0.00%	36.1%	22.2%	22.2%	13.9%
Market research into best practices	2.8%	27.8%	41.7%	13.9%	5.6%
Notes from project meetings	2.8%	25.0%	44.4%	13.9%	5.6%
Legacy system training manuals	2.8%	22.2%	11.1%	33.3%	19.4%
Legacy Code	0.0%	19.4%	33.3%	13.9%	16.7%
Social Media Research	0.0%	13.9%	22.2%	25.0%	8.3%

The functional roles most often responsible for gathering, documenting and analyzing requirements in legacy replacement projects in order of ranking were: 1) Project Managers, 2) Business Analysts and 3) Systems Analysts.

Table 10. Roles/positions which carry out gathering, documenting and/or analysis of requirements during legacy replacement projects

	Always	Often	Sometimes	Rarely
Project managers	33.33%	25.00%	27.78%	11.11%
Business analysts	22.22%	36.11%	22.00%	8.33%
Systems analysts	19.44%	38.89%	19.44%	8.33%

The survey question "How often do individuals in these roles/positions carry out gathering, documenting and/or analysis of requirements during legacy replacement projects in your organization?" was designed to establish if the requirements elicitation process for legacy-related projects is dominated by IT staff. Hereby, we aim to gauge if legacy replacement is primarily perceived as a technological issue.

In this survey section respondents were also asked to specify, in their own words, what processes their organizations follow during legacy system replacement projects. The question was deliberately designed to be open-ended, and its formulation did not specify if a requirements engineering process, or a business management process is being referred to, as organizations may not categorize their processes using such a classification. They singled out process mapping and new process updates, business process review, informal functional inventories. They also noted that the direction a legacy replacement project takes in respect to feature carryover has a strong dependency on senior management approval, on the influence of staff responsible for the systems being replaced, and on governance board-determined direction.

5.3. Survey Results Discussion

Even though the survey's response rate was not optimal, it must be noted that with few exceptions nearly all respondents represented different organizations – a total of 30 unique agencies can be discerned based on the answers from the last survey section, where organizational data is collected. Furthermore, a somewhat consistent picture emerged from the data collected – legacy systems continue to fulfill business-critical functions in government, and when replaced they significantly shape the selection, development and implementation of their successor applications.

The top reasons respondents gave for feature carryover from legacy systems were singled out to be the desire to minimize changes, end-user habit, and legislative or policy constraints. This indicates that such carryover is largely a result of internal organizational considerations, and of a choice to preserve the status-quo. While this may be the result of a legitimate concern over engaging too many resources in the technical migration and the accompanying business process changes, the potential benefits of a more substantial departure from the existing business model are not critically and systematically evaluated. "Change" is perceived as disruptive and tends to be avoided.

In the case of "legislative and policy mandates" the very label suggests immutability and serves as a deterrent to change; however, as one of our subsequent interviews revealed, during a specific legacy replacement project, legislative changes were actually pursued and accomplished. This question illustrates how self-reinforcing a legacy model can be – innovations are forestalled because of existing legislation/policies. Such policies have in many instances been adopted due to the state of technology at the time, however current modifications to legislative texts to reflect newer technology changes seem too intimidating to attempt.

No specialized approach or requirements methodology for legacy system replacement was singled out from the response data. The sources of requirements which were ranked as most useful by respondents included end-user interviews, technical documentation of the legacy system and interviews with IT staff. The high utility of technical documentation is not per se an

indication of unnecessary preservation of legacy features (i.e. of the legacy problem), but it is unclear how the analysis of such documentation informs the definition of functional requirements.

When asked to explain their organization's approach to legacy system replacement projects in their own words, survey respondents largely used procurement terminology. Standard procurement vehicles such as Request for Proposals, bids and solicitations, functional specifications, needs assessment documents, and systems analysis techniques (technical evaluations, workflow analysis, etc.) are commonly used. Yet, as noted by Mallalieu et al. [13] wicked problems are immune to resolution by using standard and formal techniques, such as the application of methods similar to the SDLC model [23], where analysis precedes implementation, and there is the assumption of a properly-defined problem. More iterative styles of implementation, "oscillating" between analysis, building prototypes and evaluating them are beneficial in cases where the effects of implementing a particular technological product are uncertain (only one of the respondents noted their organization's usage of rapid application development, or RAD, techniques). Government procurement standards do not typically employ flexible enough mechanisms [24] such as pilot evaluations, agile implementation methods, etc.

The open-ended comments supplied in the survey convey a certain dependency on executive leadership, and managerial style, or on specific agency-vendor relationships, and "political" factors, as far as decision-making on legacy replacement is concerned. A finding which prompted additional investigation during the qualitative phase of our study was that the majority of respondents singled out COTS products as their organization's preferred method of system replacement. Government IT practitioners believe that COTS packages embed business process best practices in their software [22]. Such assumptions often pre-empt the need to conduct business analysis so new or modified business processes can be defined. The options available in the COTS package are adopted and modeled after instead. However, even if a COTS product is adopted, customizations or re-configurations of it to match old features in legacy systems are still possible. Therefore, equating COTS implementation with a blank slate approach to new system adoption is not justified, and further information explicating the criteria for customization and carryover during the decision process in COTS projects is necessary.

Finally, the relatively low number of full responses to the survey is in itself an important finding. In addition to the general issues with soliciting participation from working professionals, in this case the survey's subject matter is seemingly narrow - a niche topic. There was no way of targeting those with experience in legacy system replacement projects in government organizations, as no such online groups, communities or mailing lists were found during our research. Additionally, while there is no indication that this was the leading cause for the low number of responses, several targeted recipients noted to the survey author that they felt the survey might include technical questions about legacy systems, and therefore decided they are not suitable candidates to provide information. This supports the notion, corroborated by data collected through the survey, that legacy systems replacement is largely considered a technical (and not a business) issue.

6. QUALITATIVE INTERVIEWS

6.1. Questionnaire Design

The ad-hoc nature of the approach to the legacy problem reinforced the need for a deeper, qualitative investigation of which situations and organizational contexts are conducive to more innovative replacement efforts, and which factors lead to more conservative replacement efforts and greater legacy feature carryover. We conducted a small number of qualitative interviews to gain greater insight into these issues. The respondents to the survey who provided their email address were the first to be invited for such follow-up and two of them agreed to be interviewed. The remainder of the interviewees had not completed the survey.

The interview instrument was organized into three segments. In the first segment the interviewees were asked to discuss a legacy replacement project in their organization, and were posed a series of questions which zeroed in on the dynamics of this project – what stakeholders tended to disagree about, what the typical attitudes expressed were, how the discussions typically unfolded, etc. The interviews were structured in such a way that for each thematic segment there was a list of sample questions that could be asked depending on the interviewee's narrative and the particular details they shared. The sequence of the questions also differed accordingly.

During the second segment specific requirements and procurement practices were discussed. Since during the survey COTS emerged as a preferred approach to legacy replacement, participants in the interviews were asked to elaborate on how vendors, consultants and third party companies contributed to the discussion about which features to preserve and which to phase out. Questions about how the COTS system was selected, and how requirements were put together during the procurement process were also asked.

The participants in the interviews were solicited the same way as the survey participants – by posting invitations by email, on professional forums online, etc. However, certain individuals were contacted personally as a result of recommendations and references provided by other interviewees or individuals who had completed the survey and felt that particular colleagues would provide helpful opinions due to their extensive experience. A total of 8 individuals were interviewed. Each interview was conducted for approximately 45 minutes. The interviewer took notes during the interviews and hand-recorded statements verbatim whenever possible. Audio-recordings were considered an inappropriate method of obtaining the data after several participants expressed a preference that they not be used. This is not unusual as the use of audio-recording equipment has been deemed intimidating in discussions where organizational politics are being brought up (for a review of the drawbacks of tape-recording interactions with interviewees, see [25]).

6.2. Emerging Themes

The transcripts were analyzed using a general inductive approach, which seeks to isolate recurrent concepts and categories from the raw textual data, and group them in common themes [26]. The following themes were singled out during the analysis: Executive Leadership and Power Structure, Project Logistics/ Project Management Practices, Resistance to change vs. Enthusiasm for change, Relationships with Vendors/ Consultants/ External Providers, Business-to-IT relationships. These themes will be examined in detail in this section as they

more poignantly demonstrate the wickedness of the legacy problem. Additional themes also emerged: Enterprise Consolidation, and Project Participant Personalities. While both point to factors that can determine legacy project outcomes, they are not unique to the context of public sector agencies, and we will review them in detail elsewhere.

6.2.1 Executive Leadership and Power Structure

In the survey's open-ended comments section, participants noted that the course of legacy replacement projects depends mostly on the direction provided by upper management. Interviewees similarly indicated that key mandates or the overall spirit of a project were substantially influenced by executives. If the technology implemented was meant to consolidate operations previously decentralized across different departments, top management's directives were of critical importance. This is exemplified by the following statement: "The CIO of {organization X} wasn't going to worry about fiefdoms and would come in and force people to play well together and be on the same page" (Participant ID 5). Another interview participant echoed this – "The mandate to integrate came from above." (Participant ID 2).

When executive leadership is absent legacy replacement projects often experience a "stalemate," as stakeholders pursue conflicting priorities. One interviewee described a similar situation: "We were supposed to migrate secondary systems into the new asset management system (which was an RFP), but GIS drivers were prevailing, so we are back to square one. No one has the leverage to make a decision, and everyone is reluctant {to take responsibility}." (Participant ID 4).

In certain instances, practitioners in government organizations have had limited views about what can be done with new technology. An outsider to the organization, who has seen different business and technology models, and whose views are not constrained by a historical perspective of the legacy systems being replaced, has been better able to steer projects in the direction of innovation: "We have new directors coming in {to the organization} with a better attitude who have seen other systems elsewhere. The legacy system itself is not the problem for us, but the 'industry' around it is." (Participant ID 1)

6.2.2 Project Logistics/Project Management Practices

A recurring theme in all interviews was the mechanics of gathering and analyzing requirements, or discussing current and targeted practices. Project management practices are an important factor, as meeting format [27, 28], end-user engagement, or stakeholder identification [29], and participation rules can often determine project outcomes. Discussion and analysis sessions have often been time-consuming, and their attendees – with different levels of influence in the organization. This has skewed the resulting decisions and analysis in favor of the position of those with the highest title, rather than producing an objective analysis of business process issues. Two interviewees recounted such episodes: "When we implemented {software X} we sat there for 7-8 months in fit-gap meetings reviewing every custom in the system, what {department Y} was using, what {department Z} was using. These were long draw out meetings, it was worth it but we have the Project Manager in there, and if they don't use it {the current system} daily all they do is ask "Do we need this or that, or not?" (Participant ID 5), and "The requirements meetings were a 6 hour single session, not a productive format, some people didn't speak up. Our IT project management was to blame. A good breakdown {of the process|system|requirements} would have been strategic." (Participant ID 2).

An additional obstacle to productive requirements sessions was revealed to be the discussion's level of detail. An overview of the selected technology that was too high-level was not conducive to the identification of organizational issues and needs. When companies present their software products, they might struggle to properly define the granularity of the detail they are reviewing with either the line-of-business or the IT staff in their government agency customers: "There was an as-is vs. to-be session, which was vendor-heavy and organized by the IT project manager. The session followed a vendor-provided template. Subject Matter Experts just explained their process, with a focus on exception scenarios. The drawbacks of these process were that the demos of {software company - name deleted} were high level and were not geared towards public utilities specifically. The business people hadn't touched it {the software} or "kicked it around" (Participant ID 2).

6.2.3 Resistance to Change vs. Enthusiasm for Change

It is important to note that during the interviews, it was revealed that legacy systems don't always have "interest groups" (Rauch, 1994) that overtly push for their de-facto replication, or for adherence to the status-quo. Legacy systems' drawbacks have often resulted in staff clamoring for change, because these system's usage has been so burdensome: "I sat with the employees who used the {old} forms and asked 'How much is this form chewing up from your day?' It was all done in Crystal {reports}. The guy who did them retired… this was 'great'" so now nobody could modify the report. For them to change a name of an attorney for example, it would take 2 weeks. It was like the request was going into a black hole. We needed to wait until IT could do it. " (Participant ID 5)

At the other extreme, those who have achieved a mastery of the legacy system's intricacies, or have successfully developed workarounds through other applications, may feel marginalized when the legacy system is replaced, and therefore put forward certain features of the legacy system as essential requirements. The story of an employee responsible for printing and mailing utility bills highlights the importance of engaging those who are deeply involved with the old process in the planning and implementation of replacement systems. Participant 3 recounted: "People don't like change and they are good at what they do. Staff were concerned… e.g. they were coming from {the perspective} of mechanical inserts – we sent people cards, and the guy who did it was good at decollating and carbon copy. Now he had to start using a computer. He used to take the bills to the post office. We just took it one step at a time ("How do you eat an elephant"). You just need to make them {people|staff} feel better. The comments about the new system being worse came from people who least used it."

In many organizations legacy systems are poorly documented, with business rules often available only in the form of legacy system code [30, 31]. During legacy replacement, the project participants who convey the rationale for these undocumented rules have been typically involved in implementing and maintaining the legacy system in the past, and they are providing a historical frame of reference to the business

processes in the organization. The narrative surrounding "historical reasons" often has served as a deterrent to a critical investigation of whether business process change is merited, because project participants would assume that IT systems and the workflows they support have "evolved" into their most feasible state and cannot change any further. "Historical bias" emerged as a topic during the interviews: "Often they say "it didn't work like that a long time ago". The only knowledge we have is someone's opinion from years ago. And I have seen directors walk out of meetings due to conflicts {resulting from this attitude}" and "Old and antiquated users re people with long memories who only remember the bad things" (Participant ID 1).

6.2.4 Relationships with Vendors/ Consultants/ External Providers

A varied picture of how organizations and external technology providers interact during legacy replacement projects appeared. In some cases the consultant/vendor took an innovative approach, promoting business process transformations, and in others the consultant/vendor encouraged (perhaps unnecessary) customizations to replicate legacy systems features, rules and workflows. One of the interviewees gave this example: "Another big issue/variable was that the vendor was providing the solution, and kept saying "Hey, we can customize it!" which opened the door to these unnecessary changes, and to more money being spent. A couple of SMEs have a lot of power over there and {the vendor} took advantage of that. There wasn't much change of the business process in the end other than the use of the tool. They {the vendor} listened to what the business did, took the requirements down, didn't look at {potential} business process change, didn't say "couldn't we try this?" - it was a literal translation" (Participant ID 2)

6.2.5 Business-to-IT Relations

As noted previously, legacy systems tend to be perceived mostly as a problem for the IT department, as it is often technology-specific triggers that spur their replacement (e.g. end of life announcements, incompatibility with newer hardware platforms, etc.). However, the embeddedness of these systems in business operations has led IT to increasingly involve representatives of the business operations side in the replacement process. The extent to which the discussions, analysis and decisions taken in legacy replacement projects incorporate the business perspective differs across organizations and projects, however.

Whereas the survey results indicated that legacy replacement projects tend to be IT-dominated, the qualitative interviews drew a more nuanced picture of the IT department's role, where IT staff seeks to enable and assist the business side and offer, in the words of an interviewee "a change-friendly mantra". One of the participants in the interviews described what he saw as a substantial role evolution: "IT in the past 15-20 years used to be like this "here is a product, now work this way with it". The pendulum has swung, now IT asks "what is your problem". But we can only do it {develop the right solution} if we are a part of the discussion (with the suppliers). Training in business processes, and not IT is needed because we need to look at technology as "business systems" (Participant ID 1). Participant 6 described a similar role reversal: "In {our organization} we didn't have IT push the project, it was pushed from the business perspective."

7. SUMMARY OF FINDINGS

In our study we set out to uncover how practitioners perceive the impacts of legacy systems on their agencies and how they define the requirements for applications intended to replace legacy technology. The UK's National Audit Office (NAO) report identifies legacy systems as a risk to government organizations [10]. In the survey, we have opted to pose questions about the impact of legacy technologies to agencies' operations in more neutral terms – offering respondents the opportunities to describe the benefits of legacy systems in addition to their disadvantages. According to both the survey results (including respondents' free-text comments) and the interview data, in contrast to the NAO report, the move away from legacy systems is seen as a risk in and of itself. This is an important distinction, as a different approach will be adopted when a project is undertaken to mitigate risk, than when a project is deemed to be itself a risk. The legacy problem will manifest itself more explicitly in the latter case, hence our focus on how practitioners define and perceive the role of the legacy system in their organization.

The government agencies surveyed (and these covered a variety of jurisdictions, functional and geographic areas) continue to deal with challenges stemming from the usage of legacy systems for the support of business critical operations, and for fear of operational destabilization, project managers and IT practitioners are willing to mimic the functionality of these systems in order to minimize changes. Furthermore, the survey data demonstrates that legacy replacement projects are driven by IT specialists, even where business process analysis is concerned. During the interviews, it was confirmed that the project managers for replacement projects are either themselves IT staff or have an IT background.

We paid special attention to the requirements phase of legacy replacement projects since this is when determinations about which features of the legacy systems are essential are usually made. According to the survey and the interview data, how requirements for the replacement of legacy systems are handled by practitioners in the public sector depends on a combination of both macro-level factors, such as enterprise strategy, executive direction, funding, or trends in the IT product market, and micro-level factors (personal interrelationships, preferences and attitudes). Often decisions are taken at the executive level, and the requirements analysis is conducted after the fact, and in a way as to conform to said decisions [32], as evidenced throughout the interviews. Business analysis is not singled out as a separate step or activity in such projects, but is often coupled with other project activities which may cause IT considerations to be conflated with business considerations.

Adherence to either risk aversion or to a more innovative stance is not rigidly divided by IT vs. business lines. There are proponents of both attitudes in either organizational area. While this was difficult to ascertain through the survey responses alone, the analysis of practitioner interviews revealed that the approaches of IT staff towards innovation and preservation of old business process are flexible, and often advocate change.

In the online survey, respondents were asked to describe the processes and techniques they utilize in legacy replacement projects both from pre-defined responses and as free-form comments. The interview data is closely aligned with the free-

form comments. Disenchantment with traditional project methods and practices, including planning, analysis and requirements sessions was expressed during the interviews. These methods are often formal in terms of "ceremony" [33] but not objective enough to produce an impartial evaluation and to secure stakeholder consensus. A case can be made that tools or approaches specific to legacy systems replacement type of projects might be beneficial, and that such tools should promote creative thinking so project participants can develop and assess alternative business process scenarios, rather than uncritically extend the legacy model.

Another important finding is the preference to implement COTS as a replacement for legacy systems. All interview participants had experience with such projects. According to their statements, when COTS systems were implemented, the discussion was framed by the vendor (technology provider) and an analysis of the risks and benefits of innovating business processes was rarely performed explicitly. The approach adopted often during such projects was to follow "the path of least resistance," and the focus was on making the current process fit in the new system with minimal work. A picture emerged from the interviews, of government staff too preoccupied with logistical issues – meetings, documentation, policies and rules, and perpetually involved in developing workarounds to technological, organizational, and legislative constraints, to focus on the big picture during their analysis.

Resistance to change was a given in legacy replacement projects, however it was not always overtly expressed as such. The drive to preserve the organizational status quo can often be manifested as the carryover of legacy system features perceived as essential and too risky to modify. In such instances, the wickedness of the legacy problem is revealed in the uncritical acceptance of the existing work model in the organization, and the reduction of the legacy system replacement effort to a back-end technical migration, which is ideally transparent to the business users.

8. CONCLUSIONS AND FUTURE WORK

The research on which this paper is based demonstrates that government agencies continue to rely on legacy systems for their daily operations and dedicate substantial resources to the maintenance and upkeep of legacy technology. Such technologies not only have technical limitations, but they impede public organizations' ability for business change. When legacy systems are phased out, their features often become the business requirements for the applications meant to replace them. This is problematic because opportunities for process improvement and organizational innovation are being missed. Furthermore, despite the proverbial adherence to formal procedure and highly-structured bureaucratic processes in government, respondents' agencies handled legacy systems replacement largely in an ad-hoc manner, with a preference for the acquisition of Commercial Off the Shelf (COTS) packages, which results in the de-facto outsourcing of the analysis associated with the replacement effort to vendors and consultants. Despite this, a significant level of carryover of legacy system features into their replacement applications occurred, mainly in order to minimize changes to business operations. Coupled with the finding that such projects were either spearheaded or dominated by IT staff, a conclusion can be reached that a default mantra in the project management of legacy system replacement continues to be to transition to a new

technology leaving the business process as-is, and then worry about business operations re-engineering later.

While industry and academic literature have focused primarily on the technical challenges associated with legacy systems, our research illustrates that in government agencies it is the organizational culture and work process challenges associated with legacy replacement that are more pronounced. The "wickedness" of the legacy problem was revealed in the project stories shared by practitioners. The intertwining of technology, people and political issues defies traditional IT-centric project management approaches - even when the technology is replaced, the legacy work model persists. Its imprint, often the result of resistance to change and risk-averse attitudes, impedes government organizations from achieving transformations which will improve the services they deliver to the public.

Finding ways to assist government and public service organizations in tackling the "wickedness" of the legacy problem, and in so doing enabling them to become more efficient and innovative, clearly requires further study. However, it should be noted that even in the age of the internet, with all the networking opportunities this creates (e.g. virtual communities of interest and practice, LinkedIn, Facebook, etc.), comparative research of the kind reported here proved challenging, resource heavy (in terms of time and commitment), and ultimately produced a more limited quantity of data than it was assumed would be the case. For our part, the next steps in our research programme involve using the results of the research reported here to inform the design of an interactive, action-driven, "gaming" approach which can be employed by organizations to promote diverse stakeholder engagement and creativity in tackling the legacy problem, and the evaluation of its utility in actual e-government projects.

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