2-6-2004

Is Necessity the Mother of Innovation? The Adoption and Use of Web Technologies among Congressional Offices

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NCDG Working Paper No. 04-010
Submitted 02/06/2004

This material is based upon work supported by the National Science Foundation under Grant No. 0131923. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).

I. Introduction

Communication between legislator and constituents is fundamental to effective democratic representation, and devising the institutional means for citizen/legislator communication stands as one of the core and persistent problems in the practice of democracy. A legislator needs information about the preferences, ideals, norms, and beliefs of her constituents in order to do her job well. Similarly, citizens need information about the actions and decisions of their representative in order to maintain appropriate accountability. But as national problems become more complex, and as the political process grows more and more dominated by experts and organized groups, it is becoming more difficult for interested citizens to understand the very meaning of government action, much less to find an effective voice in the process.

Recent developments in interactive information technology create new possibilities for establishing communication links between citizens and their representative. The widespread adoption and use of web based technologies among citizens creates the potential for greater citizen participation in, and knowledge and trust of, their government.[1] Web technologies allow citizens access to the government irrespective of their geographic proximity to the seat of government, and increasingly, irrespective of their wealth and educational level. When citizens have better knowledge of the hard choices Congress often has to make, and the rationale legislators have for making them, many citizens may reinvest their trust in government. Wisely used, the Internet can re-connect citizens and Congress in very meaningful ways.

A recent study by Congressional Management Foundation (CMF 2003) found that over the past year many representatives in the U.S. Congress have greatly improved the quality of their official web sites in a variety of ways, but there is still a large disparity among the offices; some offices have yet to take full advantage of capabilities for communication that the Internet has to offer (CMF 2003: 5). As we show in the next section, we can explain this cross sectional variation in the quality of Members' web sites using standard static analytical approaches that can be found in the political science literature on congressional behavior. This static analysis uncovers the political and institutional correlates of web technology adoption for members, and gives a rough outline of the incentive structure for adoption. But by its nature, the cross sectional static analysis in itself gives little insight of the dynamic process of diffusion, adoption, and effective use of web-based technologies among Members of Congress.

Members of Congress are very accustomed to, and tend to be very good at, interacting with constituents face-to-face. Digital interaction, however, is inherently new terrain for many Members, and any new activity entails uncertainty and risk; and further, implementing and making effective use of innovations requires new knowledge and new operating procedures. As a consequence, adoption of Web technologies is neither automatic nor effortless. As Dawes and her colleagues (1999: 21) write, "Throughout our history, developments in technology have emerged much faster than the evolution of organizational forms."

These considerations suggest that any study of the adoption and use of web-based innovations requires in-depth, and qualitative, dynamic analysis to identify the mechanisms of adoption and the impact of adopted technologies (as well as the impact of decisions not to adopt). To take a metaphor from institutional analysis, we need to identify the equilibrium path of new adoptions, and how to modify current suboptimal technological equilibria. This paper serves two purposes: the next section presents the results of the static analysis, and the following section

[1] The Congressional Management Foundation report that, at the state level, the average percentage of households with an Internet connection is 50% (with standard deviation of 5%). The state with the lowest percentage of connections is Mississippi (36%) and the state with the highest is Alaska (64%).

outlines our plans for future work to study the dynamics underlying the adoption and use of web technologies among Members of Congress.

II. Static analysis: Correlates of Members' adoption decisions

In this section we present a study of the political and organizational correlates of the adoption of Web innovations by Members of Congress. In many ways, the House of Representatives is a unique laboratory for understanding the effective use of information technologies in the public sector. Congressional offices function as 440 small, functionally identical, public organizations with a set of policy and procedural outputs (Salisbury and Shepsle 1981). This enables a large N statistical study of innovation adoption, in essence to test standard political science expectations that the behaviors of Members of Congress can be explained by recent electoral experience, district characteristics, and institutional resources (e.g., Fenno 1978). The statistical study yields a static portrait of the incentives for the adoption of web-based innovations.

Figure 1. CMF's "Congress Online" Website Grading Method

To assist congressional offices seeking to improve their Web sites, we set out to identify the elements critical to the success of the most effective Web sites on Capitol Hill. To this end, we conducted one year of research, beginning in the Fall of 2000, which included nationwide focus groups with citizens, interviews with scores of congressional staff, research into Web industry standards and best practices, and surveys of political reporters and advocates.

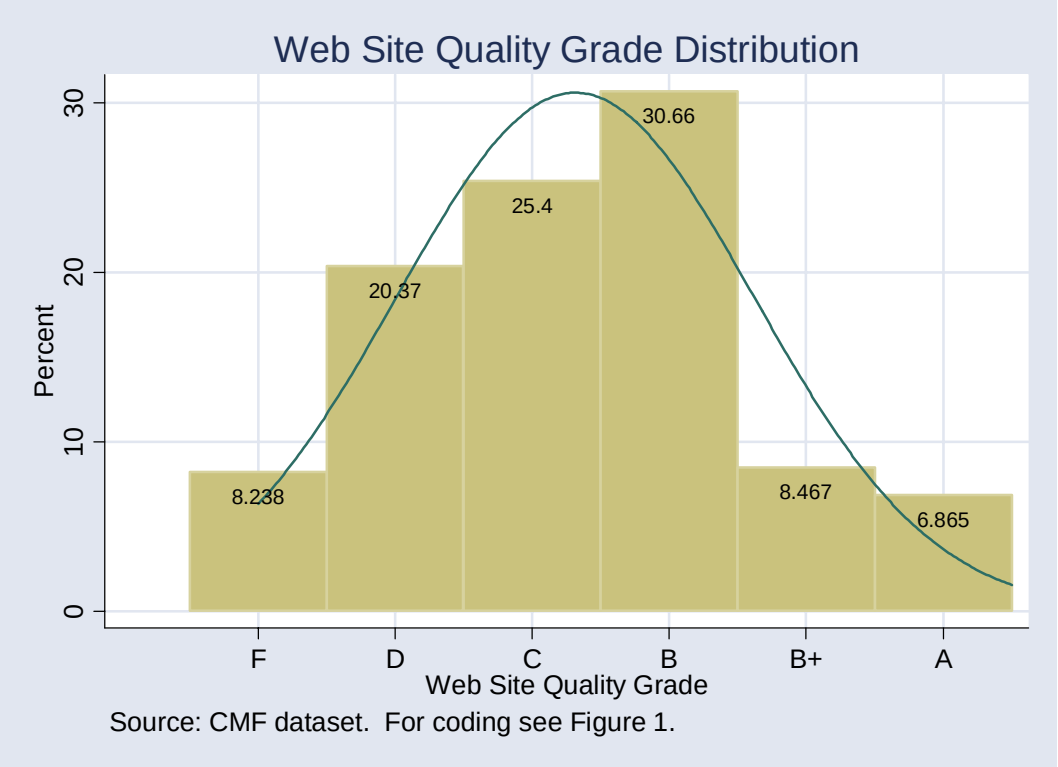
Through our research, we identified *five building blocks* that underlie the success of the most effective Web sites on Capitol Hill. In order of importance, these are:

1. Audience. The Web site conveys the sense that the office has clearly identified its Web audiences, both those seeking information from the office and those that the office wants to target, and has methodically built the site around those audiences.
2. Content. The site provides up-to-date information that is specifically targeted to meet the needs of the defined audiences. This information attracts new visitors and supports the goals of the office.
3. Interactivity. The Web site offers its visitors opportunities to express their views and fosters on and off line communication.
4. Usability. The design and information architecture of the Web site provide quick and easy access to information and services.
5. Innovations. Creative features enhance visitors' experience on the site by making it more interesting or easier to use.
Using these five building blocks as our foundation, we devised *an evaluation methodology* that would be fair and objective, while still taking into account important qualitative factors that affect a visitor's experience on a Web site. These other factors include: the quality and tone of the information presented; the usability and navigability of the site; its look and feel; and the degree to which the information meets visitor needs.
Our evaluation process was conducted between August and November 2002.

Source: "Congress Online 2003: Turning the Corner on the Information Age," Congressional Management Foundation, 2003, p. 3.

Dependent variable. The dependent variable for our analysis is an ordered categorical rating of the *Quality* of each member's web site, as measured by the Congressional Management

Foundation (CMF), on a 6 point grading scale ranging from A to F. The grading scale is based on a content analysis of each web site that measures the degree to which the web site met five criteria relating to audience, content, interactivity, usability, and innovations, as well as some overall qualitative judgment (see Figure 1). Figure 2 shows the distribution of web grades.



Source: CMF dataset. For coding see Figure 1.

Independent variables. The explanatory variables in the model are a standard list of incentives and constraints for members, including measures of the electoral situation, the local district situation, and the intra-institutional situation. Table 1 provides the summary data for the independent variables, described next.[2]

Electoral situation. It is well-known that Members of Congress generally seek re-election. In the model we include two variables that tap into the member's electoral situation. *Margin of previous electoral victory*. Those with narrower victories have incentives to reach out to constituents in every manner possible. *Tenure in office.* Members gain greater electoral security with longer tenure in office due to the well-known incumbent advantages. Members with longer tenures in office have fewer incentives to seek out innovative ways to interact with constituents than those with shorter tenures. In addition, Members with longer tenures are more likely to have well-established ways of communicating with constituents.

[2] The election margin, tenure, percent of connected households, gender, age, and political party variables come from the CMF dataset. The provision of educational services, gross state product, and electrical equipment manufacturing variables come from census data collected by Michael Hannon, a graduate student at Ohio State University, and all measured for the calendar year of 2000. The land area and the other district level variables mentioned in footnote 2 are from Scott Adler's website, department of political science, University of Colorado. The coding for party leader, chair, and ranking member comes from the opensecrets.com web site.

Local situation. Representation inherently requires attention to district needs and interests. In the model we use state level measures for these variables, which will serve as rough measures of district characteristics.[3] *Percent of households in the state with internet connections* measures the capacity and the interest of citizens to use online services and to contact their member through web sites. *Provision of educational services (in millions of dollars for year 2000)*, measures the degree of formal education in the state population, another dimension of the interest and capacity of citizens to contact government officials through online media. *Gross state product (in millions of dollars for year 2000).* A third measure of citizen capacity; wealthier citizens should place greater demands for communicating with members through the web. *Manufacture of electronic equipment in the state (in millions of dollar for year 2000s).* Organized interest group politics often drives members' choices, and the amount of production of electronic equipment serves as a proxy for industry interest in technological innovations. *Land area (in square miles)*. Members with larger districts may feel the need to use innovative web technologies where communication does not depend on geographic proximity.

Institutional situation. The institutional context within Congress also can create advantages and disadvantages for members to undertake new initiatives. *Political party*. This is a dichotomous variable coded 1 if the Member is a Republican, and 0 otherwise. Members in the majority party should have a greater share of internal resources to organize their offices; consequently Republicans should tend to have better quality websites than Democrats. *Party leader, committee chair, or ranking member*. Members in leadership positions tend to have greater resources for managing their offices, and so may have greater opportunities for adopting innovations

Table 1. Summary Statistics for the Independent Variables

	N. of obs	Mean	Stand. Dev.	Min.	Max.
Electoral Situation					
Margin in Previous Election	437	68.88	13.55	47	100
Tenure	436	5.52	3.83	1	23
Local Situation					
% Connected Households	433	50.43	5.17	36.1	64.1
Educational Services (millions $)	433	3475.3	3181	32	10463
Gross State Product (millions $)	433	448861	390919	18124	1330025
Elec. Equip. Manuf. (millions $)	433	7522.2	9292	1	29867
District Land Area (sq. mi.)	435	8035	30567	10	570373
Institutional Situation					
Political Party (Republican = 1)	440	.497	.500	0	1
Leader, Chair, or Ranking Member	437	.109	.320	0	2
Other					
Gender	440	.138	.345	0	1

[3] We estimated separate, but similar, models using the district level measures that are available in the Adler dataset. These measures were from 107th Congress (1997-8). Oddly, these district level variables lacked explanatory power, potentially because of intervening redistricting. In contrast, the state level measures reported here have strong explanatory power. One possibility is that the state level measures indeed are the correct level for analysis, for example if members base their adoption decisions on state characteristics or if there is strong diffusion of web technologies within a state delegation. In subsequent drafts we will seek out more recent district level measures to better distinguish between state-level and district-level effects.

Method. We next present results for an ordered probit statistical model. The coefficients in a non-linear statistical model have no substantive meaning in themselves. Instead, in the text we present "first difference" effects, which set all variables equal to their mean and counter factually change a typical member on the variable of interest from the minimum to maximum (see Table 1). For ordered probit models, a first difference analysis estimates the change in probability of receiving each grade due to the conditional change of the independent variable in the counter factual simulation. We estimate the standard error of the first difference effects using the Clarify software developed by Gary King and his colleagues (www.gking.harvard.edu). In the model we cluster the standard errors by state, since we assume there may be dependence among members in each state delegation through similar (unmeasured) state circumstances and possibly through diffusion of ideas within the state delegation.

Results. Table 2 gives the raw ordered probit estimated coefficients, and Table 3 shows the first difference effects. Again, the first difference effects give a substantive interpretation of the magnitude of the effect of each independent variable that is estimated in the model. Each cell of Table 3 shows the estimated impact of the independent variable listed in the column on the probability of receiving each grade that comes from changing the independent variable from its minimum to its maximum, while holding all other variables constant at their mean. One can think of a first difference effect as a "thought exercise": based on the model estimates, how much does the quality grade of a typical Member's web site change, and in what direction, if one were to counterfactually change the independent variable measure from low to high.

The variables measuring Members' electoral situation, not surprisingly, have a strong and robust effect on the overall quality of Members' web sites. Counterfactually changing a typical member's electoral margin in the 2000 election from 47% to 100% (uncontested) leads to a 20% decrease in the member's probability of getting a grade of "B" or higher. This result is not surprising since the re-election incentive is strong, and one would expect members to increase district communication of all types in competitive districts. Similarly, increasing a typical member's tenure from 1 year (freshman) to 23 years leads to a 30% decrease in the probability of getting a grade of "B" or higher. This result too is expected since seniority helps to confer a member an incumbency advantage, and at the same time members with a longer tenure in office will have established standard operating procedures for communicating with constituents.[4]

We include several variables in the model that measure the demand and the capacity for local constituents to gain access to their Member's web site. For reasons we report in footnote 3, all but one of these variables were measured at the state level. The percent of households in the state that are connected to the Internet is a measure of the individual-level constituent capacity to access the member's web site, and also a proxy for the demand among constituents for web-based information and services. We find that increasing the percentage of connected households from 36% to 64% leads to a 28% increase in the probability a typical member will receive a grade of "B" or higher. A second measure of citizen capacity to access information from members' web sites is the degree to which citizens are formally educated. Our measure for extent of formal education in the locality is the local supply of educational services measured in dollars. The point estimate of the coefficient for this variable is positive as expected, but not significant; this is because education is highly correlated with state wealth, which we control for in the model. But by the point estimate, increasing the level of educational services from $32 million to $10 billion leads to an 11% increase in the probability the member will receive a grade of "B" or higher.

[4] Age is also highly correlated with tenure and seniority, and because of this we do not include the member's age as a separate variable in the model. The effect from age, if any, will mostly be picked up by the estimate for tenure.

To measure the demand for technology-based communication among local organized interests and firms, we include a measure of the total output in the electronic equipment manufacturing sector. Increasing sales in this sector from $1 million to $30 billion leads to an estimated 33% increase in the probability the member receives a grade of "B" or higher. Surprisingly, increasing the state's wealth, as measured by the state gross product, leads to a substantial decrease in the quality of the Member's web site; increasing state gross product from $18 billion to $1 trillion leads to a 44% decrease in the probability of receiving a "B" or higher. Potentially, Members who represent the less wealthy states and districts feel the need to establish low cost means that enable constituent communication.

Finally, in terms of institutional resources and support, being in the majority party seems to help; Republicans are 8% more likely to receive a "B" or higher than Democrats. In addition, once tenure and seniority are controlled for, being in a leadership position such as party leader, committee chair, or ranking member does not seem to have any effect.

Table 2. Predictors of Web Grades (Ordered Probit Full Model Results)

	Coefficient	SE	P > t
Electoral Situation			
Tenure	-.038*	.014	0.008
Margin in Previous Election	-.009*	.003	0.013
Local Situation			
Connected Households	.025*	.009	0.004
Educational Services (in millions $)	.0000276	.0000188	0.142
Gross State Product (in millions $)	-9.50e-07*	3.06e-07	0.002
Electronic Equipment Manuf. (in millions $)	.000029*	8.35e-06	0.001
District Area (in square miles)	-1.67e-06	1.14e-06	0.144
Institutional Situation			
Political Party (Republican = 1)	.203*	.106	0.056
Leader, Chair, or Ranking Member	-.046	.152	0.760
Other			
Gender	.161	.145	0.267
Auxiliary Parameters			
Cut Point 1	-1.009	.629	---
Cut Point 2	-.156	.646	---
Cut Point 3	.530	.652	---
Cut Point 4	1.497	.636	---
Cut point 5	1.990	.646	---

Note: Statistically significant model coefficients ($p \leq 0.05$) are denoted with an asterisk. Cut points estimate Z-score values of an assumed normal distribution that separate the dependent variable categories into probability areas.

Discussion. These cross sectional findings confirm the standard expectations in the political science literature on U.S. congressional behavior: the quality of Members' web sites, as in other decisions, is heavily dependent on the Member's political and institutional situation. To distort the familiar aphorism, necessity appears to be the mother of the adoption of web-based innovations among Members of Congress. Shorter tenure and closer electoral margin both independently contribute to successful web innovation adoption; members appear to adopt new technologies when the marginal benefit of doing so increases; and institutional resources and support appear to matter, all pretty much as expected.

Table 3. Estimated Change in Probability in Receiving Grade, Marginal Effects							
	Electoral Situation		Local Situation				Institutional Situation
Web site Grade	Election Margin	Tenure in Office	% Connected Households	Educational Services	Gross State Product	Electronic Manufacturing	Political Party (Republican)
A	.078	.174	-.106	-.036	.245	.023	-.028
	(.034)	(.090)	(.038)	(.025)	(.099)	(-.138)	(.015)
B+	.094	.130	-.133	-.055	.186	.039	-.039
	(.036)	(.037)	(.044)	(.039)	(.047)	(-.222)	(.021)
B	.024	-.005	-.038	-.021	.004	.035	-.011
	(.011)	(.022)	(.012)	(.016)	(.020)	(-.159)	(.006)
C	-.088	-.158	.116	.044	-.212	.018	.033
	(.037)	(.061)	(.037)	(.031)	(.065)	(.047)	(.017)
D	-.051	-.072	.074	.030	-.106	.025	.022
	(.020)	(.027)	(.025)	(.022)	(.030)	(.039)	(.013)
F	-.056	-.067	.088	.038	-.117	.060	.024
	(.022)	(.020)	(.030)	(.028)	(.038)	(.047)	(.012)

Note: Cells give the estimated change in probability for each grade that comes from a counter factual simulation, where a Member typical in all respects is assumed to change the column variable from its minimum to its maximum. Standard errors for the changes in probability are given in parentheses; standard errors are estimated using the Huber-White method and are clustered by state. Only statistically significant marginal effects are reported in this table. For the full model, see table 2.

Limitations of the large N study. The large N study, while interesting in itself, does not answer other substantively important questions regarding the diffusion and use of digital technologies inside of Congress. What is the specific process of diffusion of web-based innovations? Are there early innovators? Do members with better quality web sites also make better and more efficient use of feedback from constituents in their offices? In other words, the static analysis asks more questions than it answers, and this is fruitful. The large N study does show there are systematic determinants for adoption; adoption is not haphazard but instead is generally a purposeful response to Members' political situation. This strongly suggests the underlying dynamic processes of adoption and use can be understood systematically as well.

III. Summary of one approach to the a dynamic analysis of adoption and use

Web based technologies can have a significant impact on representatives and citizens alike. What are the specific mechanisms that lead to the diffusion of web-based technologies among Members' offices? Do members with higher quality web sites also make more efficient and effective use of the feedback from constituents that interactive web sites produce? Do better quality web sites lead citizens to believe that the representative processes is more transparent, engender greater trust in online government among citizens, and improve civic knowledge and discourse? In the next phase of this research, we intend to study these and other substantive questions to help fill in our understanding of digital government in Congress, and as a way to assist Congress, through the continuing efforts of CMF, to improve its web interface for citizens.

Diffusion processes. As in the more general case of e-government (Fountain 2001), the technical possibilities that the internet creates must pass through the prism of existing institutionalized arrangements as embodied in the current set of routines, expectations, belief structures, norms, and communication patterns. As a practical matter, given the decentralized nature of Congress, much of Congress's organizational learning occurs within its "informal" organizational structure such as the social networks among offices and staff, and with IT entrepreneurs as agents of innovation diffusion (see Whiteman 1995).[5] Prior research has shown that, while hierarchies are generally efficient for carrying out specialized tasks based on explicit rules and procedures (Arrow, 1974; Cohen & Bacdayan, 1994; Cyert & March, 1963, Weber 1968, Weiss, 1998; Williamson, 1975), informal networks more efficiently diffuse, utilize and integrate innovations (Grant & Baden-Fuller, 1995; see Brown & Duguid, 2001; Grant, 1996; Kogut, 2000; Kogut & Zander, 1996; Nault, 1998, Podolny & Page, 1998; Powell, 1990).

In future research we intend to analyze Members of Congress and their staff as a social system in order to explore how Web practices diffuse among Members and their offices. We will examine the organizational and institutional positions of Members of Congress, as well as the structure and contents of ties between Members, their staff, and between offices (see generally Nahapiet and Ghoshal 1998; in the context of Congress, see Salisbury and Shepsle 1981; Whiteman 1995). Particularly important in this process are *change agents*, who are frequently more technically competent than their peers, but can still communicate the essence of the innovation to them effectively (Rogers, 1995:19).

Effective use. Clearly, the use of online technologies in the deliberative process will only strengthen the processes of democratic representation if Members are responsive to constituents' feedback received through these new channels, and are willing to rethink the ways in which to use the feedback. Engaging citizens in an electronic democracy is an old concept that is to be

[5] Congress requires some infrastructural support to facilitate new techniques of Web-based government. The House provides basic technical services to facilitate the adoption of Web-based innovations through the offices of the House Information Resources (akin to services provided by an Internet service provider), but offices must make their own planning, purchasing, and maintenance decisions about computers, servers, Web sites, software, peripherals, and IT management.

carried out in a fundamentally new context; the adoption of traditional deliberative engagement to the digital government context, and the incorporation of online feedback into internal office routines, requires a higher-level learning, or fundamental changes in the underlying norms, policies, and procedures for the use of constituent feedback. In other words, this sort of organizational change involves "double-loop learning" (Argyris & Schön, 1978), or learning how to learn (c.f., Cyert & March, 1963; Nelson & Winter, 1982, Epple, Argote, & Devadas, 1991 with Argyris & Schön, 1978:3, Cummings, 2002, and Huber, 1990). In light of this, we intend to conduct an in-depth qualitative study of the internal processes of Members' offices, exploring how changes in technology affect the ways in which Members react to citizen feedback, and how Members' offices cope with technological innovations in terms of capacity, routines, and skills.

Citizen response and effective feedback. One touchstone in the design of new innovations is the need to involve end users in both the design and deployment of the innovation (Dawes et al. 1999: 20). Both representatives and constituents differ in their capacity and interest in using online technologies, and come from a variety of backgrounds and locales. To consider citizen reactions to Members' web sites, we intend to conduct a larger N systematic study. To conduct this study we would cache members' web sites that vary in their attributes. We would then recruit citizens from members' districts to view the web site and complete pre- and post-online surveys that measure citizens' responses along dimensions of the quality of information presented, usability, interactivity, and trust. In the analysis, the attributes of the web sites, and the demographic attributes of the participants, would serve as explanatory variables in a model that tests the effect of different web site attributes on citizen response to the web sites.

A Unique Research Collaboration. Three collaborating organizations are integral to our ongoing research as full intellectual contributors: the National Center for Digital Government, the Congressional Management Foundation, and the U.S. House of Representatives Committee on House Administration. The NCDG, an "NSF national center of excellence," is the focus at Harvard's John F. Kennedy School of Government for research on information technology, institutions, and governance (see www.ncdg.org). The goal of the Center is to apply and extend the social sciences for research at the intersection of governance, institutions and information technologies. CMF is a non-partisan, non-profit organization that has provided management services to the U.S. Congress for twenty-five years. Since 1997, CMF has been tracking ICT adoption, use, and innovation in Congress and possesses the most thorough data available regarding congressional ICT practices and attitudes toward ICT adoption. CMF's role as a link between the academic researchers and the Congress is crucial. CMF has a long record of research into Congress's ICT management practices that will serve as the starting point for our research; they will facilitate the academics gaining access to Congress; and, through its longstanding relationship with Congress, CMF can help to translate the products of this research into concrete suggestions for improving the real-world practices of digital government in Congress. The Committee on House Administration (CHA) has jurisdiction over the financing, management, and administration of services to the House of Representatives. It has jurisdiction over the service-providers in the House of Representatives, including the Office of the Chief Administrative Officer, which provides the technical infrastructure and support for all House offices. As such, the CHA has the ability to study, finance, and implement technological innovation and information management in the House of Representatives.

IV. Summary

In sum, we argue that the static cross sectional study of the determinants of web-based innovations among congressional offices presented in this paper goes a long way toward uncovering the correlates of adoption and the basic incentives Members have to adopt. But we feel that the most fruitful research lies ahead as we begin to study the dynamic processes underlying the adoption and use of web technologies.

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