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Leaders and Lemmings: Organizational Responses to Smart Grid Transformation

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ABSTRACT

After a century of relative stability in the electricity sector, introduction of the smart grid has triggered a period of great uncertainty with the potential for wide-spread and long-lasting impacts. When faced with pressures that threaten established institutionalized practices, incumbent organizations may respond in a variety of ways, ranging from resistance to manipulation. This paper reports the findings from a qualitative field study that explores how utilities, the organizations at the core of the electricity sector, are responding to institutional pressures and what it means for their deployment of smart grid technologies. Under coercive and mimetic pressures, utilities respond with avoidance by taking a wait-and-see approach, or acquiescence, simply following direction of others. In contrast, organizations that perceive benefits of smart grid technologies beyond the need for compliance adopt manipulation strategies, becoming more engaged in shaping the transformation and experimenting with new technologies to enhance their stature and performance.

Keywords

Smart grid, institutional theory, organizational change, qualitative research, field study.

INTRODUCTION

The history of technology is full of new innovations that were considered revolutionary at the time. Some of these have changed the social landscape, while others have had only modest impacts or faded quietly into the background (Hughes and Cosier, 2001). One innovation expected to have a major impact on society in the twenty-first century is the smart grid. Defined as the suite of advanced information and power technologies deployed in the generation, transmission and distribution of energy resulting in an intelligent and integrated environment (McDonald, 2008), the smart grid represents a revolutionary transformation of the electricity sector (Spring, 2009) that will have wide-ranging impacts on individuals, organizations, and society for the foreseeable future. Although advances in power engineering have improved the reliability and efficiency of the electrical grid, the basic structure has remained relatively unchanged for decades (Farhangi, 2010; Spring, 2009). Beyond the fact that many technical components of the grid have now exceeded their expected lifespans, raising the risk of failures across the system, the current grid has structural limitations that make it difficult to incorporate the new energy sources, achieve a more efficient distribution of electricity, and adapt to changing customer demands (Weiss, 2009). These limitations result in inefficiencies that are both financially and environmentally costly. With respect to environmental sustainability, the smart grid holds enormous promise because the generation of electricity is a major contributor to global greenhouse gas emissions. Therefore, researchers within the IS discipline have been called to examine how advanced information systems and smart technologies can help to support and promote the 'greening' of this vital sector (e.g., Dedrick, 2010; Watson and Boudreau, 2011).

The most fundamental difference between the traditional grid and the smart grid is the addition of multidirectional information flows across the entire electricity value chain. Combining advanced information systems and communications technologies with power system engineering, the smart grid will add intelligence to the infrastructure and allow utilities better visibility and control over their processes and assets (Farhangi, 2010; Spring, 2009). With its new capabilities, the smart grid will have many advantages over the existing grid, including distributed generation (e.g., by customers) and cogeneration of energy; self-monitoring and correction of the grid; integration of alternative sources of energy; carbon footprint management; demand response management through smart metering and integration with home area networks and smart appliances; improvements to service quality control; and increased customer control over energy consumption decisions (Farhangi, 2010; McDonald, 2008).

Despite the promise of the smart grid, challenges remain on many fronts. As IS research has found, the path of technology innovation is not always straight-forward. Tushman and Anderson argue that "technology evolves through periods of incremental change punctuated by technological break-throughs that either enhance or destroy the competence of firms in an industry" (1986, p. 439). Utilities, which are situated at the center of this changing landscape, are feeling these pressures most directly. By eliminating the constraints of a rigid, one-way infrastructure, IS embedded in the smart grid will provide opportunities for improved business practices as well as new business models. With business model innovations operational requirements are often different from, and incompatible with, existing business models making it difficult for incumbent organizations to compete as effectively as new entrants (Markides, 2006). Thus, not only do utilities need to protect or enhance their own competencies, they must also deal with the threat of new entrants. Inevitably, utilities will have to fundamentally change to adapt to these new realities.

Despite significant financial investments in the smart grid in practice, IS scholars are only beginning to focus attention in this area (e.g., Corbett, 2011). Therefore, the aim of this paper is to advance research on this topic by exploring how utilities are responding to the challenges of smart grid transformation. Specifically, the study addresses three questions: 1) what pressures are influencing utilities' adoption of smart grid innovation, 2) how are utilities responding to these pressures; and 3) what are the implications for IS? Given the highly institutionalize nature of the electricity industry, and recognizing that organizational change is a complex social process "in which forces for transformation are offset by forces of persistence" (Robey and Boudreau, 1999, p. 182), this study draws institutional theory to help frame and guide the investigation.

The remainder of the paper is structured as follows. In the next section, an overview of institutional theory is presented, with particular attention focused on the sources of pressures that lead to institutionalization and organizations' reactions to them. Then, the research methodology of the study is explained and the findings of the study are discussed. The paper concludes by outlining the contributions and limitations of the study, and future directions for research.

INSTITUTIONAL THEORY

Institutional theory dates back to the seminal work of Philip Selznick (1948) on the theory of organizations. In this work, an organization is seen as the structure that enables rational action to take place. Additionally, organizations are considered adaptive, social structures that respond to and influence the values, actions and concerns of those who form them (Scott, 1987; Selznick, 1948). While formal structures, such as hierarchy and policies, may initially provide the context of organizational activities, over time, gaps, constraints, or contractions in the formal structure may result in new routines, or patterns of behaviors that become widely adopted and "institutionalized" within the organization (Selznick, 1948). These institutional structures may exist anywhere within the organizational hierarchy (from individuals to industry levels) and may work to either strengthen or weaken the existing formal structures; however, once in place they generally become more resistant to change (Robey and Boudreau, 1999; Selznick, 1948). These structures are considered critical to the survival of an organization as they provide the necessary stability, control and identity that allow the collection of individuals to function in a coordinated and efficient manner (Fortune and Aldrich, 2003; Selznick, 1948).

While initial conceptualizations of institutional theory focused on those aspects that made organizations different, the theory has also been applied to understanding why organizations become similar. Over time, the variation within an industry or field diminishes as there is an "inexorable push toward homogenization" (DiMaggio and Powell, 1983, p. 148). The concept of institutional isomorphic change refers to the constraining processes by which organizations within a given field are compelled to become like other organizations given the same environmental conditions (DiMaggio and Powell, 1983). The mechanisms of institutional isomorphic change fall into three categories. First, coercive isomorphism stems from formal and informal pressures, government mandates or persuasion and seeks to address the problem of legitimacy for an organization. Second, mimetic isomorphism is driven largely by the management of uncertainty and is manifest in the form of imitation or modeling of other successful organizations. Third, normative isomorphism results from increased professionalism as members of the field seek both collective and individual definition around their work (DiMaggio and Powell, 1983). Institutional isomorphism predicts that in emerging fields, the degree of uncertainty around the processes, goals, technologies and structures will lead to increased pressure for homogenization and that mimetic mechanisms, whereby organizations seek to model those who are perceived to be most successful, will be most prevalent (DiMaggio and Powell, 1983).

When disruptive technology or other institutional pressures arise in an organizational field, there is a tendency of organizations to become more similar to each other. However, faced with similar pressures, some organizations respond with isomorphic actions and others respond with non-isomorphic actions (Ang and Cummings, 1997; Delmas and Toffel, 2008; George, Sitkin and Barden, 2006). These differences may exist because of the resistance of organizations' own institutional structures (Robey and Boudreau, 1999; Selznick, 1948) or because of strategic decisions made by management (George et al., 2006; Oliver, 1991).

A typology of strategies, ranging from passive to active responses has been proposed in response to this phenomenon (Oliver, 1991). At one end, organizations may adopt a strategy of acquiescence by giving in to the institutional pressures (Oliver, 1991). In this case, the organization may form habits, imitate models, or comply with rules and norms, which is consistent with other views of institutional acquisition (Scott, 1987) and mimetic isomorphism (DiMaggio and Powell, 1983). At the other end of the spectrum, the most active strategy is that of manipulation (Oliver, 1991). Organizations with this strategic perspective are likely to seek to co-opt the institutional forces, reshaping and influencing them to be more aligned with the organization and looking to dominate the institutionalization processes (Oliver, 1991). Between these two ends of the continuum, organizations may take a strategy of compromise, by attempting to balance the competing interests of multiple stakeholder interests and pressures; avoidance, by disguising the non-conformity or changing goals to eliminate the pressure to conform; or defiance, in which they ignore norms and values, contest rules or attack the sources of institutional pressures (Oliver, 1991). Empirical studies have confirmed the overall soundness of this model (Clemens and Douglas, 2005) with relatively minor adjustments. Perhaps the most significant variation on the model relates to the manipulation response. In the original conceptualization (Oliver, 1991), manipulation was seen as the most active form of resistance. However, other studies have suggested that manipulation responses are more similar to those of acquiescence or compromise and may also reflect the most active, productive response by the firm to institutional pressures (Clemens and Douglas, 2005).

Other studies have provided insights into factors that moderate the organizational response at multiple different levels (Elbannan and McKinley, 2006). For example, more coercive pressures (e.g., regulatory requirements) evoke different strategic responses than mimetic or normative pressures (Ang and Cummings, 1997); the nature of the industry and level of risk affect the tradeoff between conformity and non-conformity (Alessandri and Khan, 2006); organizational characteristics such as size temper the responses to institutional pressures (Ang and Cummings, 1997), and the degree of organizational resistence may be impacted by the different level of influence among organizational functional groups that are subject to the institutional pressures (Delmas and Toffel, 2008). Finally, the research has also considered that a firm's strategic decision to adopt or imitate others depends not only on their willingness to do so, but also an accurate identification of what to imitate and their ability to actually do so (Jonsson and Regner, 2009). In summary, research in institutional theory suggests that organizations, although subject to similar external pressures to change or create institutional practices may react in different ways. Therefore, in order to anticipate the transformative effects of the smart grid, it is essential to explore how utilities, as agents of change for the smart grid, are responding to external pressures and the potential implications of these responses.

RESEARCH METHODOLOGY

In order to understand utilities' responses to smart grid, a qualitative field study approach was employed. To gain a wide perspective on the institutional pressures and organizational responses by utilities, semi-structured interviews were conducted with twenty-two participants from eleven different organizations in the North American electricity industry. Participants represented organizations from several perspectives in the industry: seven utilities, one system operator, one industry association, one software vendor, and one consultant. A snowball approach was used to recruit participants. Beginning with connections made at industry conferences and within the researcher's professional network, participants were asked whether they could recommend others (both within and outside of the organization) for interviews. The interviews took place in person over the six month period between June and December 2011. Where participants agreed, interviews were recorded and then transcribed verbatim. In four situations, participants did not permit recording of the interview; however, notes were taken by the researcher during the interviews and then transcribed. Anonymity of participants as well as the organizations was provided in order to try to encourage participants to speak freely. In addition, where practical and possible, multiple participants were interviewed from the same organization which provides a more complete picture of the organizational responses through triangulation of subjects, and helps to minimize the effects of single informant bias (Miles and Huberman, 1994; Myers, 2009).

Once the interviews were transcribed, qualitative analysis was performed using techniques suggested by Miles and Huberman (1994) and Saldana (2009). An initial set of codes was developed using the three categories of isomorphic pressures (coercive, mimetic, and normative) based on the descriptions of DiMaggio and Powell (DiMaggio and Powell, 1983). Drawing from the literature, five codes were also established for organizational responses: acquiescence, compromise, avoidance, defiance and manipulation (Clemens and Douglas, 2005; Oliver, 1991). Finally, the last part of the initial coding scheme captured information related to actions taken by the organization to implement components of the smart grid, such as smart metering, data storage, analytical information systems or other IS related infrastructure. With this set of nine codes, the transcripts were then reviewed and coded by the researcher. Subsequent phases of analysis examined patterns and themes that emerged within the data (Saldana, 2009). These findings are discussed next.

FINDINGS

Throughout the interviews it became apparent that the potential changes resulting from the smart grid are viewed as unprecedented within the industry. As one participant succinctly commented: "*this is one of the biggest changes, one of the biggest paradigm shifts that utilities have to realize and do something about.*" (P17, Utility).

From an institutional theory perspective, the data also showed that there is significant pressure on utilities to change century old business practices and adopt smart grid technologies. The results of this study reflect two main sources of isomorphic pressures. Above all else, the first-order influence is coercive, driven predominately by regulatory requirements and utilities' need for legitimacy (DiMaggio and Powell, 1983). Across North America, legislation or regulatory requirements related to smart grid varies with some jurisdictions assuming a more aggressive timeline than others. Thus for some utilities, moving to smart metering, implementing demand-side management and energy efficiency programs, or incorporating renewable energy sources into the electricity supply mix are now part of licensing requirements and are thus non-negotiable. However, even beyond regulatory pressures, utilities recognize that their legitimacy and long-term survival depends on up-dating their infrastructure and advanced IS are an essential part of that. Additionally, individuals' use of IS across other domains such as online services and eCommerce, are elevating the expectations that customers have of their utilities. For instance, with respect to presenting consumption data on the website or enabling mobile utility apps, this is perceived as a necessary condition imposed by customers: "*I think that's just an expectation of our society is that sort of stuff should happen*" (P5, Utility).

Although there seems to be no doubt with respect to the inevitability of smart grid, many of the details of what the smart grid is and how it will work have not been set. Not surprisingly, a change of such magnitude comes a high degree of uncertainty across all areas of the utilities' businesses. Therefore, technological uncertainty, in particular questions about how to proceed with the adoption of smart grid technologies are prevalent. In the past, utilities had confidence in devices and other grid infrastructure that lasted forty or fifty years. However, with intelligence now being built into physical devices, there are new concerns about technological obsolescence and it implications for the utilities and regulators alike. As one utility participant commented: "*Here, technological obsolescence will come long before the asset has reached what might be considered a reasonable life, whether that's 15, 20 or 25 years. And that's a big challenge for the regulator, because that's not the basis on which they've traditionally approved capital expenditure plans. It is very possible, I hope not, but it's entirely possible we've gone with the Betamax solution, and the VHS is really the long-term.*" (P3, Utility).

A second level of IS uncertainty relates to communications and the evolution of standards: "*Where the rest of the world's going, though, is still a big open question in a lot of areas. There's a lot of competing standards. You have a lot of different countries that are now getting involved for the first time and have their own ideas about how to do things. There's a bit of an international tug of war on some of these standards. And then within the U.S., too, you have different companies that have their technological roadmaps or piggybacking on different standards. Some of them are compatible with one another, some of them aren't, so it's a dicey area right now*" (P6, System Operator).

Finally, there is uncertainty about how to deal with the tremendous volumes of data that are and could potentially be collected by smart meters and other devices. As one participant observed: "*Data storage is quickly growing into the elephant in the room, because the amount of data we're collecting now has just exploded. We have over 7 TB of data in less than a year, and we're only doing one-hour intervals. Now we can store 7 TB of data, but I'm not so sure we can very efficient at looking through 7 TB of data if I want to find something.*" (P11, Utility).

As a result of this heightened uncertainty, a second form of isomorphic pressures is evident: mimetic. When dealing with uncertainty within the operating environment, organizations may feel pressure to model the structures, decisions or actions of more successful, leader organizations in order to help minimize the risk of uncertainty and gain legitimacy within the industry (DiMaggio and Powell, 1983). While expressed repetitively by all industry participants, the pressure to follow others is particularly salient with the small and medium size utilities: "*Clearly for the smaller and medium [electricity distribution companies] we see all this happening. This is all a precedent setting.*" (P1, Industry Association).

Although utilities face similar pressures to adopt Smart Grid technologies due to coercive and mimetic forces, there are variations in how utilities are responding. When utilities are faced with these coercive and mimetic pressures, the findings suggest two predominant responses: avoidance and acquiescence (Oliver, 1991). In an industry as highly regulated as the utility sector, utilities do not practically have the option of out-right defiance. However, they can avoid many of the most difficult issues by taking a wait-and-see approach: "*So the utilities are sort of waiting to see, what do they do next? When do they start? They've been told they can do pilots. When do they start making long-term investments at smart grid? That's what they're sort of waiting for. And they want some guidance*." (P1, Industry Association). A second response of utilities is to accept the mandate and begin implementing new technologies, albeit with a relatively low-level of commitment: "*There are* *many utilities, so there are many different attitudes. But some will say, 'Well, this was a government decision. We don't really have a say in the matter.' And they'll try to be indifferent about whether it's good or bad. 'We're just doing it.'*" (P8, System Operator). Taking this strategy allows the utility to demonstrate to stakeholders that it is moving forward, yet reduces the risk by not accepting full responsibility or ownership of the change. In effect, this approach gives utilities an out in the event that conditions change or things go bad.

Although the reactions of many utilities to the smart grid so far have been tentative and passive, the data also reveals a subset of the industry that is embracing a more proactive role in shaping the smart grid transformation. These utilities can be categorized as those that look beyond the regulatory requirements to see the greater potential benefits of change. For instance, when asked if his utility was mandated to implement advanced metering infrastructure or smart grid capabilities, one participant replied: "*So we don't have to… We can continue operating as we've been operating for the last hundred and ten years. We can continue doing* [things] *the same way. We can run equipment to failure. When it fails, we replace it. But it's not the way we want to run our business.*" (P17, Utility). This attitude of wanting to change the business and to become more progressive, not just for compliance, was acknowledged by several participants. For them, adopting this approach also lead to a more active response, which could best be described as manipulation (Oliver, 1991). In the case of the smart grid, however, the manipulation is not a sign of resistance to the change, but rather indicative of positive and productive efforts (Clemens and Douglas, 2005) to define the standards and effect necessary changes to transform the industry. As one of participants with a senior role in his organization's smart grid initiatives remarked: "*I work in direct support of the presentations, strategy analyses, working in terms of building our industry profile or evolving the market. And advocacy is a role I fill.*" (P3, Utility). Besides working the political side to influence the smart grid, these utilities take a more hands-on approach to implementing smart grid technologies and innovation. They are early adopters of new technologies and systems, develop pilot programs to test new capabilities, and experiment with different approaches. Not only do these organization gain valuable internal knowledge and expertise through these efforts, but they also become perceived as leaders and their influence in shaping smart grid regulations and operating parameters is enhanced.

In summary, the findings demonstrate a wide spectrum of organizational responses and this has contributed to a heterogeneous roll-out of smart grid. From an IS perspective, this suggests that flexible approaches and technologies are needed in order to address the uncertainty and volatility as the smart grid continues to evolve. A second, a perhaps more troubling implication of these findings is the evidence of somewhat mindless adoption of smart grid technologies resulting from responses to mimetic pressures. As one participant commented: "*Utilities are lemmings. We don't necessarily need AMI* [advanced metering infrastructure]*, but it is cool.*" (P8, Utility). The risk in this situation is that billions of dollars invested by governments and paid by utility customers could be wasted by the inappropriate acquisition and deployment of IS that do not support improved efficiencies or provide other organizational benefits. Moreover, the wait-and-see attitude raises the risk of stifling new IS innovations by utilities who are sitting on the sidelines waiting to see what will emerge. For years, the electricity sector has not placed a great emphasis on information systems and technologies. However, with the smart grid, the industry will become information intensive. For an industry that is already far-behind other advances in IS, a lack of innovation could seriously imperil incumbents and lead to even more dramatic changes as new entrants seize the advantage. To counter-act this risk, utilities will need to become more aggressive in building new organizational capacities, particularly in respect of IS. Therefore, another implication is that there will be a greater demand for IS skills within this domain. As one utility manager explained: "W*hat we'll probably see as a result of the smart grid is a little bit of decrease in that side of the labor pool* [power linemen]*, and an increase in the IT-skilled side of the labor pool. Because we're going to need more people to administer these systems, we're going to need more people to figure out how come a relay isn't talking to the rest of the system, that I don't think the regular lineman education training provides today. We'll still need somebody that can go out there and splice cables and stuff, but the importance of the software side of things is going to increase dramatically.*" (P5, Utility).

CONCLUSION

As a disruptive technological innovation, the smart grid holds both tremendous promise and risk for utilities and the entire electricity sector. The ultimate outcome will depend on how utilities respond to the prevailing pressures for change. As the findings of this study illustrate, utilities' responses range from avoidance to active engagement, depending in part on where they perceive the strongest driver for change. With utilities adopting different approaches to the smart grid, progress on this transformational journey will be bumpy, slow and at times unpredictable. Although IS has not traditionally played a large part of the electricity sector, it is becoming increasingly important and embedded as the smart grid takes hold. As one of the first empirical studies on the smart grid from an IS perspective, the paper contributes to the IS literature by providing a view into organizational responses to the smart grid transformation and identifying key implications for IS with respect to the smart grid. In particular, the research highlights the need for IS expertise to support technological innovation and to collaborate with non-traditional partners, such as power engineers to in order to facilitate the smart grid evolution and realize all of the smart grid's potential benefits. It is recommended that future research build on these themes and bring IS knowledge to bear on addressing the challenges face by utilities as they re-define their operations and business processes.

Although the study provides new insights into an emergent IS research area, it is not without limitations. Most importantly, the study involved a relatively small number of participants and organizations. As a result, the ability to generalize the results is limited and the findings should be considered as indicative rather than definitive. In the United States, for instance, there are over 3200 utilities across the electricity value chain from generation through distribution. These utilities vary in terms of size, ownership, and are subject to a set of complex federal, state and regional regulatory frameworks. The full extent of these variations have not been taken into account in this study, but further research that examines responses and smart grid adoption across a larger group of utilities would be helpful in confirming the findings and identifying additional insights.

Over the past century, electricity has become a cornerstone of modern economic, environmental, and social structures. The traditional electricity grid has served us well in terms of providing a safe and reliable supply of electricity to meet our needs. However, the traditional grid is outdated and no longer suitable for dealing with the new requirements of environmental sustainability and energy security. Enabled with advanced information systems, the smart grid holds significant promise and potential for taking us through the next century, but only if it is adopted and implemented with careful consideration. Therefore, we call on IS scholars to apply their deep knowledge and expertise in this area in order to help make the smart grid a reality.

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