IDENTIFYING HIDDEN PATTERNS DRIVING ADOPTION AND REJECTION OF INNOVATION

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Abstract

This study presents a complexity theory approach to decision systems analysis (DSA) through an examination of asymmetric algorithms for adoption and rejection of solar panels in a business-to-business context. DSA facilitates the representation of the complex and non-linear nature of non-routine decision-making behaviour in case study research. This research assumes a non-reoccurring quality to non-routine decision making, however complexity theory suggests that a closer view of these non-linear outcomes may reveal adaptive non-linear networks, which are governed by logical rules and give rise to patterns between similar interactive networks. This self- organizing, bottom up perspective on decision making processes reveals intricate systems that give rise to asymmetric rules. Through asymmetric algorithmic representation of causal factors, this research works towards developing an adaptive, relational, non-reductionist representation of factors present in the adoption of innovative technology in a business-to-business context. The study uses DSA to represent observable and unobservable factors in the innovation adoption process, which is supplemented with binary variables pertaining to the sentiments and beliefs of decision making managers. The intention of this exercise is to provide a basis for configurational analysis consistent with the principles of DSA, which can be used to test tenets of complexity theory. The research extends prior work by Woodside and Baxter (2013) in developing accurate, complex and generalizable methods for analysing business-to-business case study processes.

Key words- complexity theory, decisions systems analysis, asymmetric algorithmic representation

Work in Progress Paper

Introduction

This study presents a methodological approach to facilitate the identification of complex patterns across volumes of information on innovation adoption processes in business-to-business (B2B) contexts. The approach builds on the understanding that different theories and methodologies can be used in blended forms to provide approaches entirely appropriate for representing emergent phenomena (Woodside & Baxter, 2013). In developing and blending existing methodological approaches, the research works towards providing an alternative approach to the dominant logic based on overly simplistic notions of symmetrical modelling (Woodside, 2017). The degree to which dominant analytical tools, such as regression analysis, have shaped outcomes themselves is significant. Paraphrasing Maslow, when you have a hammer, everything looks like a nail. In demonstrating this approach this study looks at the innovation adoption process of Small-to-Medium Enterprises (SMEs) in the B2B solar panel market. Information was gathered in a four-step process- firstly, suppliers of solar panels were interviewed using long and semi-structured formats to gather an understanding of the factors that they believe influence the adoption or non-adoption outcomes of their suppliers. The outcome of these interviews was used to build the guidance for subsequent semi-structured interviews with potential business buyers. As a second step, semi-structured interviews were conducted with adopters of solar panels. Their responses were then mapped using Decisions Systems Analysis (DSA) and the respondents were sent a mapping representing their adoption or non-adoption process and asked to comment on its completeness and accuracy. As a final step, once all interviews were conducted, each buyer was asked to respond to a binary statement concerning the presence or absence of sentiments and beliefs held, based on the matters discussed with other respondents. Once all respondents had addressed all sentiments and beliefs raised by the group, their sentiments and beliefs were represented as binary variables and expressed as asymmetric Boolean algorithms for acceptance or rejection of the technology. These algorithms allow for analysis of the relationship between and comparability of the chosen factors within and between equations. These asymmetric algorithms can also be applied as causal recipes for adoption and non-adoption of solar panel technology. The importance of interviewing the supplier is that this provides comparison and correlation of perspectives on the same process, from the perspective of buyer and seller, this form of triangulation, addresses some of the limitations a respondent has in retrieving and reporting on their own thinking process (Woodside, 2010). The paper addresses some of the inadequacies of multi-regression, as identified by McClelland (1998) in representing the complexity of relationships between antecedent conditions. The research builds on advanced theory through maintaining the integrity of individual cases, essential for the analysis of relationships between antecedent conditions to the extent required for testing the tenets of complexity theory.

Conceptual background

Early research in B2B decision making was oriented towards positivist, quantitative approaches in particular, economic modelling, which vastly underrepresented the complexity of the business environment. As Cyert, Simon, and Trow (1956) explain—(They) treated alternatives as given and failed to consider the search for alternatives as a key aspect in the decision-making process. In much the same way, neo classical economic modelling presented consequences and alternatives as given, regrettably overlooking the process involved in determining consequences and alternatives from a realistic business perspective (Cyert, et al., 1956). Further to this, decision making was seen to fill only one business objective,

individual characteristics of decision makers were not considered, nor were specificities relating to the structure of the entity. System dynamics and DSA has facilitated the representation of the complex and non-linear nature of non-routine decision-making behaviour in case study research. Landmark studies including Observation of a Business Decision (Cyert, et al., 1956) have pioneered a shift in paradigm to a comparative method, case-based logic, critical of the fit between rational choice process theories and real-life process information (Woodside & Ferris-Costa, 2006). Cyert, et al., (1956) emphasised the relevance of their work through the outcome of the case they studied. An agent sought a quote for a computer system, then hired a consultant to advize him on the quote, then didn't adopt the technology as the wealth of information available in decision making was too complex and overwhelming. Using economic modelling to represent B2B decision making oversimplified a highly variant and dynamic process.

In developing a more sophisticated representation of decision making, appropriate for "non-programmed" (Cyert, et al., 1956) decision making, such as innovation adoption, emergent paradigms present a more anthropological approach. Narrative techniques have paved the way for a more gritty and complex view of decisions, critical of the limitations of memory and the verbal communication of past events (Woodside & Megehee, 2009). A substantial body of business research now considers a more complex and dynamic view of the decision-making process, which can be obtained through long and fluid interviews, as well as the triangulation of relevant data (McCracken, 1988). As discussed in Howard, et al., (1975) the idea of modelling an entire organizational system is infeasible and thus a scaling down of aspirations and a shift away from larger models has seen an opportunity for modelling greater variability in situational detail. Rather than modelling decision making as a stoic concept, research methodology has evolved to represent the process as a dynamic, feedback driven relationship.

Mixed method research strategies have further developed the scientific legitimacy of B2B decision making literature. Morgenroth (1964) laid foundations for a blending of epistemologies by presenting storytelling detail in a system dynamics model, then organized case outcomes using binary heuristics to study and simulate the flow of price decisions. This work contributed to filling a gap between qualitative and quantitative research by retaining greater complexity, accuracy, and detail, simultaneously producing outcomes that are to some degree generalizable (Woodside & Baxter, 2013). General level theories have been used individually and in blended forms, giving rise to a wealth of research opportunity in developing mixed methods of B2B research, while avoiding ontological and epistemological tensions.

Woodside and Baxter (2013) suggest how case study research methods could be used in samples of between 5-50 cases in order to develop isomorphic theory. They emphasise the importance of avoiding reductionist arms-length surveys, which distort the complexity of relationships and thought processes (Woodside & Wilson, 2003). This detail provides an opportunity for sophisticated observers to notice subtle patterns in intricate webs of relationships (Weick, 1979). Effectively integrating aspects of these existing tools is an exercise in shifting perspectives- from great intricacy, to comparable metrics, effectively zooming in and out, as required, to identify meaningful relationships. Capturing and (re)interpreting complexity in multi-firm disruptive product innovations demonstrates how shifting perspective can enhance and bring meaning to pre-existing data (Pattinson & Woodside, 2008).

Complexity theory

The tenets of complexity theory are a relevant progression and consideration in building on existing systems theory. Complexity theory considers patterns, interactions, and changes over time, which are realistic 'real world' adjustments to an effective, yet largely reductionist approach to the analysis of dominant managerial decision-making systems. A gap in systems theory relates to the analysis of the complex, evolving, and emergent nature of relationships between factors and events (Wu, et al., 2014). In particular, complex adaptive systems, such as adaptive non-linear networks, that deal with interconnected and integrative properties evident within and between seemingly unrelated systems (Comim, 2000). Complexity theory is not a single theory, but rather a range of theories, all of which address the understanding of complex systems (Manson, 2001). The process of B2B decision making is a highly complex system and involves preferences and biases of decision makers, influences of sellers and other individuals, the development and interaction of sentiments and beliefs, as well as a vast array of other observable and non-observable influencing factors. Complexity theory sets forth tenets which seek to address understanding highly complex interactive systems Comim (2000) explained the following tenets, pertaining to adaptive non-linear networks:

T1. Dispersed interaction, where the interaction of independent and variable agents gives rise to novelty in global results. Complexity theory explains that interaction governs outcomes, rather than a centralised source of control.

T2. Organisation and co-ordination exists at multiple levels, giving rise to a hierarchy of organisation.

In consumer literature, complexity theory has been used to deepen analysis and to transcend dominant logic in case study research. Wu et al (2014) introduced complexity theory to the service dominant logic perspective by analysing customer satisfaction in terms of boolean algebra and asymmetric analytics, rather than matrix algebra and symmetric analytics. The authors identified four propositions consistent with complexity theory and tested them in terms of customer satisfaction using asymmetric analytics (Wu, et al., 2014). The effectiveness of this method was demonstrated by calculating outcomes using conventional techniques, such as ANOVA and regression analysis and comparing them to the complexity theory results. It was found that complexity theory tenets are a useful advance in consumer behaviour. Wu, et al., (2014) demonstrated the following tenets in consumer literature, pertaining to non-linearity and asymmetry of outcomes:

T3. The possibility of negative contrarian cases, whereby low scores in an antecedent condition can result in either low or high scores in an outcome.

T4. Asymmetry in causal recipes for positive and negative outcomes, whereby the causal recipes that result in adoption outcomes are not mirror opposite of causal recipes that result in non-adoption.

The relevance of a complexity approach to analysing B2B decision-making behaviour is that the subtlety, nuance, and delicate interactions that can ultimately determine outcomes, are not ignored. In a positivist approach, where observable, stoic factors are identified and mapped, the role of interaction between factors is overlooked. Complexity theory suggests that interaction itself is a determinant underlying factor in decision making and thus requires analysis as a discreet actor of influence.

Method

A shift in paradigm from positivist to complexity theory logic, axiomatically drives a shift in method. In order to gather the degree of detail, understanding and complexity required to understand relationships between individuals and factors, ethnographic techniques are required to break through some of the limitations of traditional case study research (Woodside & Wilson, 2003). Due to the nuanced nature of complexity theory in consumer behaviour, a high degree of detail is required at the information gathering stage. The long interview method explored by McCracken (1988) demonstrates how interviews can be used to reveal information and attitudes that would likely be overlooked though the use of positivist, fixed-point surveys (Woodside & Wilson, 1995). In gathering further perspective, interviews are conducted at multiple points in time, by interviewing multiple respondents involved in the process and in multiple environments, or in the normal place of business (McCracken, 1988). Multiple interviews of the same respondent addresses to some degree the difficulty that a respondent has in remembering, retrieving and communicating their past thought processes to a researcher (Woodside & Wilson, 2003) . As the tenets of complexity theory rely on unobservable variables, accessed through self-awareness and self-reflection, the semi-structured nature of the long interview can be used to ask probing questions. The non-linear nature of complexity theory requires an understanding of the evolution of relationships between factors over time and in response to environmental changes, rendering detailed insight essential for research. The long interview technique seeks to understand the respondent's worldview, without which isolated factors cannot be fully understood. Respondents are not interviewed with the intention of revealing specific variables, but rather their lives are mined for the most relevant information in a lightly structured conversation. When using the long interview method, respondents are not a sample, thus sampling rules are not appropriate for selection. As a rule of thumb, four to eight subjects are normally interviewed (Woodside & Wilson, 1995).

In this study, the decision-making process was mapped using a concept map with time and observability used as the key dimensions and represented as axes. Complementing this method, asymmetric equations were used to represent the presence and absence of factors, in this case sentiments and beliefs, which resulted in adoption and non-adoption outcomes. This eclectic mix of methods allows for the testing of several intuitive and counterintuitive propositions, set out as tenets of complexity theory. The building of core propositions from data overcomes apparent conflicts in superficial propositions, to reveal what is core to theory (Woodside & Wilson, 1995).

Preliminary empirical findings

Figure is an example of one buyer's decision-making process, illustrating the development of sentiments and beliefs through time and across various levels of observability. The vertical axis represents observability and the horizontal represents time. The buyer interviewed is the owner and manager of a wholesale fresh food supplier based in Sydney, Australia. The owner had solar panels installed on the business premises in 2017 and the interviews were conducted in March 2018.

The interviews were based loosely on questions about the innovation adoption process, the company, supplier, and product characteristics. The respondent was interviewed twice at two separate points in time. He was first asked to describe events, interactions and sentiments and beliefs, then asked to comment on the mapping. Figure below represents his revised version of the process.

Case 1- Food manufacturer

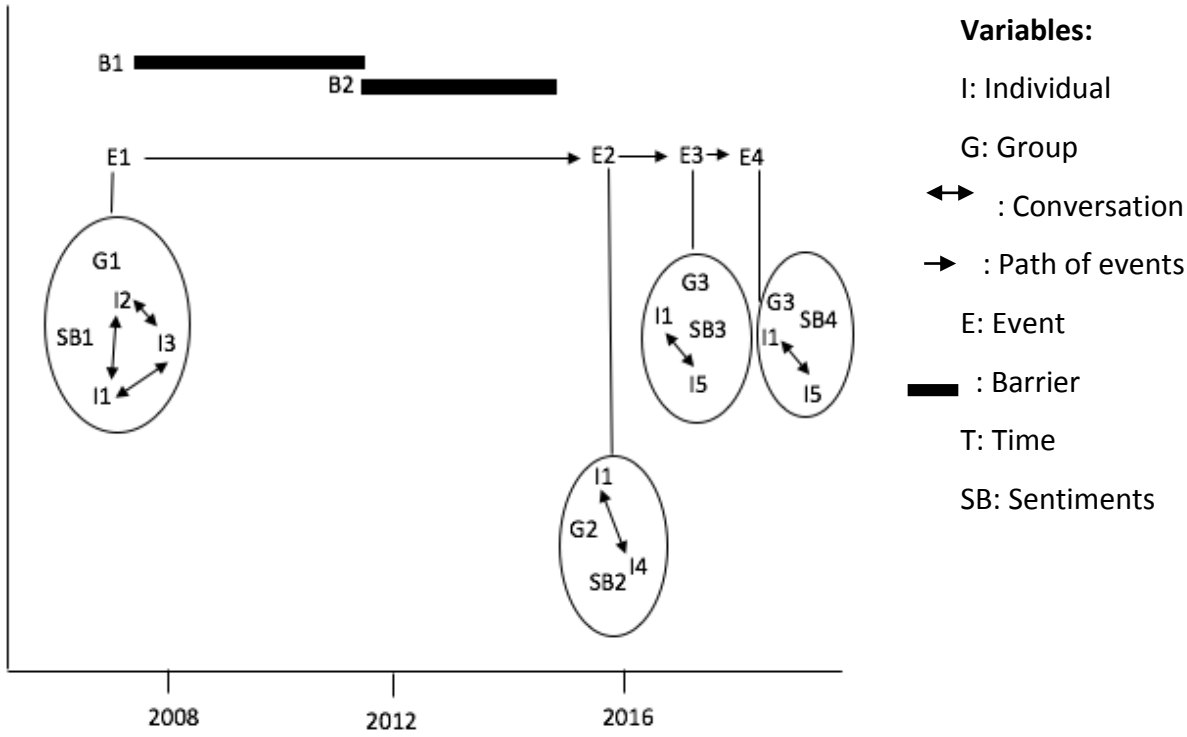

Figure: DSA supplemented with binary variables
Source: Original figure, but relates to Calder (1977) and Woodside & Baxter (2013)

Variables mapped in this first interview were as follows-

E1	Observed profits from solar installations through government rebate schemes while working as an accounting consultant
E2	Golf day- I2 asked I1 to buy a solar system from I2's brother (I5)
E3	I5 first visit to I1's production facility
E4	I5 second visit to I1's production facility
B1	I1 did not own manufacturing business yet
B2	Rented premises not appropriate for installation
I1	Key decision-making individual
I2	I1's former business partner
I3	I1's former consulting client
I4	Friend of key decision-making individual
I5	I2's brother, a solar panel salesman
G1	Former work network
G2	Friendship network

G3	Transaction group
SB1	There is a lot of money to be made from installing solar panels
SB2	Incentive to buy for business networking reasons/ social pressure
SB3	Sceptical of contracts that offer free services
SB4	Time pressure

The sentiments and beliefs revealed were converted to high/low binary variables, providing a platform for the consideration of relationships, essential in identifying patterns in relationships across data collected from different interviews. The expression of these binary variables enables the complex configurational analysis required to test the application of selected tenets derived from complexity theory. Sentiments and beliefs revealed through the DSA mapping (Figure) are represented in the following equation (•=present; ~=Not present):

(SB1•SB2•SB3•SB4) = SPA (Solar Panel Adoption) (1)

The subject began to develop sentiments and beliefs concerning solar panel adoption around 2008, when he was working as a consultant for a business that made profits from organising solar panel installation for companies, then compensating themselves through government incentives. From this point onward, the respondent felt that solar panel installation was an effective way of making money. In 2011, the respondent bought a food manufacturing company, however from purchase until 2015 the business was located in temporary premises, where the respondent did not feel it was feasible to invest in the technology. In 2015 the business moved to permanent premises and shortly after a friend asked the respondent to speak to his brother about installing panels on the company building. The respondent spoke to the salesperson twice, at his place of business and on the second visit his decision was made and a contract for installation was signed.

Case 2- Sporting goods supplier

The exercise was repeated for a second respondent. The following equation was derived:
(SB1~SB2~SB3•SB4•SB5•SB6~SB7) = SPA (Solar Panel Adoption) (2)

The additional sentiments and beliefs raised as part of his interviews were as follows-

SB5	Electricity companies are taking advantage of consumers
SB6	European businesses are leading the way of the future with solar technology
SB7	Belief that there is financial risk involved in installing solar panels

The first buyer was then contacted a third time to confirm the presence of absence of the sentiments and beliefs held by the second respondent. His revised equation was as follows:

(SB1•SB2•SB3•SB4~SB5~SB6•SB7) = SPA (Solar Panel Adoption) (3)

Using binary equations to test complexity theory

This paper considers how equations (2) and (3) might be used to demonstrate tenets T1 and T2. In considering how interaction governs outcomes, rather than a centralised source of

control (T1), the first two case outcomes indicate that there may be an interesting relationship between time pressure and belief in significant financial reward. While in a positivist sense they can be seen to be simply positively correlated, complexity theory prompts the researcher to consider how time pressure and financial incentive might interact in the mind of a decision maker. The equations also allow for the consideration of the nature of this relationship, for example, whether time and financial pressure have an augmenting cyclical relationship, which may require one of a number of additional factors to trigger adoption.

The equations can be used to consider organisation and co-ordination at multiple levels (T2). For example, a researcher might consider SB1 and SB4 together, as the most relevant influencing factors, then consider which factors might contribute to positive SB4, giving rise to a hierarchy of organisation. Where positivist methods may reveal multicollinearity of factors, analysis of binary equations can be used to identify levels of relationships and causes.

As the extent of interviewing has been limited to two positive adoption outcome cases, information is not available to demonstrate the possibility of negative contrarian cases or asymmetry in causal recipes for positive and negative outcomes. The development of this methodology would however be well suited to testing this asymmetry as a hypothesis.

Conclusion

This paper outlines the theory and method for testing the tenants of complexity theory in the business-to-business innovation adoption process. The paper follows an emergent shift in paradigm away from positivist logic. Methodologies consistent with positivist logic are ill-adapted for understanding the complexity of innovation adoption. A focus on more asymmetrical logic, analysis of complex configuration of causal pathways, and consideration of decentralised organisation of antecedent conditions could contribute to an enhanced understanding of the drivers of buying behaviour. As markets become more complex and decision making is influenced by a growing volume of factors, the positivist paradigm is losing traction and a review of emergent literature presents alternative paradigms vying for the dominant position (Woodside & Ferris-Costa, 2006). The consideration of complexity theory and the application of its tenants in this transient period, could make a significant contribution to the emergence of a new dominant paradigm in B2B decision making literature. As the working paper has only considered positive adoption outcomes, the existence of false positives and false negatives, as not yet been considered, however the methodology presented builds foundations for a study where blips in data are embraced rather than ignored. The inclusion of such information further enables researchers to look thoughtfully at the relationship between factors present in the adoption process, including entire networks of factors and their interaction at different levels. The methodology is appropriate for the specific project described, as well as for application to any other innovation adoption process.

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