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Abstract: Research in business model innovation has identified its significance in creating a sustainable competitive advantage for a firm, yet there are few empirical studies identifying which combination of business model activities lead to success and therefore deserve innovative attention. This study analyzes the business models of North America low-cost carriers from 2001 to 2010 using a Boolean minimization algorithm to identify which combinations of business model activities lead to operational profitability. The research aim is threefold: complement airline literature in the realm of business model innovation, introduce Boolean minimization methods to the field, and propose alternative business model activities to North American carriers striving for positive operating results.

Key words: airlines, low-cost carries, business models, innovation, Boolean, qualitative comparative approach (QCA), TOSMANA

Introduction

Research of industry transformation often identifies technological innovation as the foundation of transformation (Christensen, Anthony, & Roth, 2004; McGahan, 2004). However, subsequent research has highlighted that industry transformation is increasingly attributed to business model innovation (Chesbrough, 2003; Linder & Cantrell, 2000a; Markides & Charitou, 2004; Markides, 2006; Mitchell & Bruckner Coles, 2004; S. Voelpel, Leibold, Tekie, & von Krogh, 2005); firms, such as Enterprise Rent-A-Car, Unilever, and Dell, are often cited as introducing industry transforming business models not reliant on technological innovation. Technological innovation, such as the jet engine, has led to airline industry transformation. However, the industry experienced a radical transformation with the introduction of the low-cost business model following deregulation (Doganis, 2006; Henderson & Clark, 1990; Taneja, 2004). This model's efficiency and cost-conscious processes challenged traditional industry thinking and transformed travel.

Incumbent, full-service carriers are operating in a challenging landscape and past innovative attempts have centered on imitating the low-cost model through creation of low-cost subsidiaries, such as Continental Lite, Delta's Song, or Shuttle by United (Doganis, 2006; Graf, 2005). Failure of these imitative brands is partly attributed to business model incompatibilities between the two models (Graf, 2005). At the same time, low-cost carriers are not immune to competition and constant business model evaluation is necessary (Alamdari & Fagan, 2005). The research and aviation communities lack a methodology to identify which combination of business model activities lead to profitability and thereby deserve innovative attention. This paper addresses the issue empirically through utilization of a Boolean algorithmic minimization analysis of a selection of North American low-cost carriers' business models from 2001-2010 to identify which combination of business model activities contribute to operational profitability excluding fuel expenditure. The aim of this paper is threefold: to shift the airline literature stream towards business model innovation, introduce Boolean minimization methods to the field, and propose alternative business model activities to carriers striving for positive operating results.

This paper is presented in six parts. The preface precedes a theoretical introduction to the business model and innovation themes. A background explanation of the airline industry and business model literature follows. Next, a methodological presentation of airline selection criteria and Boolean analysis is described. The analysis results are then presented. This is followed by a conclusion that includes industry importance and areas for further research.

Theory

Business model research has expanded its application to all industries (Linder & Cantrell, 2000b; Linder & Cantrell, 2001; Magretta, 2002) since its inception in 1998 by Timmers (1998) in the electronic business field. A business model is understood as a framework for how a company creates value for its desired target market, which leads to sustainable financial success, and achieves long-term strategic goals. It is essentially a story of how a company competes (Afuah, 2004; Magretta, 2002) through a composition of numerous elements (Chesbrough, 2003; Hedman & Kalling, 2003; Osterwalder, Pigneur, & Tucci, 2005), of which the main ones are:

- Target market
- Value proposition
- Activity set
- Network partners
- Profitability analysis

The theme of innovation has increasingly been incorporated in business model research. Past research has focused on technological advancements as a form of competitive advantage (Chesbrough & Rosenbloom, 2002; Christensen, 1997; Danneels, 2004; Henderson & Clark, 1990). This concept disregards the success of service firms that are not reliant upon a technological base but rather a superior business model (Moesgård Andersen & Poulfelt, 2006). Christensen's (2003) work on technological innovation stresses that new innovations eventually become industry standard; business model innovation stresses that new models coexist with incumbent models, although the new business model may capture a significant share of the market, as witnessed in the bookstore, bank, or airline industries, however they are not a threat to eradicating the incumbent model (Markides, 2006). In addition, research highlights that a competitive advantage is obtainable through business model innovation (Markides, 1999; Markides, 2004; Markides, 2006; S. C. Voelpel, Leibold, & Tekie, 2004; S. Voelpel et al., 2005). Business model innovation implies that a company does not necessarily deliver a new product or service, but rather discovers a new way of serving a market through adjusting any or all of the business model elements. However, as business models age they become obsolete, imitated, or commoditized which necessitates constant innovative transformation (Tucker, 2001).

Background

In the context of the airline industry there are four broad categories of business models: full-service carriers (FSC), low-cost carriers (LCC), regional, and charter (Bieger, Döring, & Laesser, 2002; Bieger & Agosti, 2005; Doganis, 2002; Doganis, 2006; Taneja, 2004). This paper directs its attention on the LCC business model which is challenged by FSC competition, increasing market encroachment from other LCC competitors, a depressed economy, and other exogenous events such as fuel price volatility, which indicates that the business model is ripe for benefiting from innovation (Franke, 2007). Business model differentiation among low-cost carriers is a strategic option in a competitive landscape.

Among the various business model elements in an airline the activity set is the most visible, and where the majority of innovation takes place. While the value proposition, target market, and network partners may remain relatively stable, the activity set may go through constant change to adapt to market forces. There is disparity regarding the airline business model activity set as there is currently little agreement in the community regarding this definition, however, this paper proposes to analyze the LCC business model airline activities shown in Table 1, which is complemented by the a column showing the traditional LCC business model description (Alamdari & Fagan, 2005; Lawton, 2002).

Table 1:
Analyzed LCC activity set

Category	Activity	Traditional LCC
Distribution	GDS distribution	No GDS presence
Ticketing	Through-fares	No through-fares
	Ticket restrictions	No ticket restrictions
Amenity	Lounge access	No lounge access
	Frequent flyer program (FFP)	No FFP
	Single class	Single class
Organizational	Online connections	No online connections
	Interline connections	No interline connection
	Regional airline feed	No use of capacity provider
	Single fleet	Single fleet

All airlines have adopted the Internet and the benefits of online distribution, however some LCCs have chosen to also distribute their tickets via the older global distribution systems (GDSs), which may be more costly but penetrate more market segments (ATW, 2006). Online distribution strategies, which are less costly, are not incorporated in the analyses since all carriers utilize this distribution strategy. Ticketing activities include researching through-fares and restrictions, both activities that the traditional LCC business model bypasses.

Through-fares[1] are reduced fares for one- or more stop routes with the same airline and which increase LCC revenue management complexity but improve customer flexibility and expand network reach. Ticketing restrictions, such as Saturday night stay requirements, reduce customer flexibility but increase firm revenue, are often touted as not part of the traditional LCC business model. Amenities offered by airlines include lounges and frequent flyer programs, which may enhance service but also costs and complexity, and are excluded from the traditional LCC model. In addition, LCCs are often touted as having a single-class cabin rather than attempt to raise additional revenue from higher levels of service in multi cabin aircraft. Finally, organizational activities include online and interline connections, the use of capacity providers, and a single fleet. Online connections, which allow users of airline services to transfer to other flights with the same airline, allow an airline to increase its network and appeal to customers with the negative impact of complexity and cost. Interline connections are an activity that allow passengers to transfer between airlines. Traditionally, these two activities are not part of the LCC activity set. Use of a capacity provider is the investigation of LCCs relying on regional carriers to operate flights requiring the use of smaller aircraft or a lower cost base. This is often incorporated in the FSC business model, however is avoided in the traditional LCC model. Finally, a single fleet is often touted as a mainstay of the LCC business model, however fleet variation is found among the sample group[2]. These activities are similar to those identified by Taneja (2004), Bieger and Agost (2005), Alamdari and Fagan (2005), and Doganis (2006). Operational aspects were omitted from this analysis because they are reflections of a chosen business model, rather than input variables open to innovation.

There are various dependent variables to describe the success of a chosen business model, such as net profit, operational profit, market share, customer satisfaction, etc. This paper proposes operating profit excluding fuel expense as a measure. Operating profit is often used as a measure of success with airline business model research (Alamdari & Fagan, 2005). However, its inclusion of fuel expenditure with its recent volatile price fluctuations may mask successful business models. Therefore, annual operating profit excluding fuel is calculated. While this variable describes the business model performance of an airline, the sample group all reported operational profits excluding fuel in the sample years, which challenges the analytical method described below. The solution is to compare each annual operating profit excluding fuel with the median of the airline's operating performance for the sample period.

Methods

This section describes the study group selection criteria and explains the Boolean algebraic analytical tool. The study group is comprised of the largest LCCs from North America. This region was chosen due to its level of deregulation, private ownership, high level of competition among LCCs and other business models,

[1] Through-fares were researched via online price checks on respective airline sites for flights requiring at least 2 legs (i.e. with one or more stops en-route) and comparing prices for the same flight on individual legs.

[2] Aircraft models and their variants are considered as a single model (e.g. Boeing 737-600 and 737-900 or Airbus 320 and 321).

and a high level of standardized data collection. Other markets continue to grapple with regulatory concerns and public ownership issues, which place constraints on business model innovation ((Garvett & Hilton, 2002). This selection methodology led to the study group presented in Table 1. Annual business model and financial data was collected for the identified study group between 2001 and 2010 to provide a longitudinal study of business model innovation within the industry, and to identify which recent innovations contribute to operational profitability. Data was collected by reviewing each airline's websites, annual reports, US Bureau of Transportation Statistics data, and secondary sources in industry-specific journals and magazines.

Table 2:
LCC sample for Boolean analysis (2001-2010)

Low-cost carrier sample 2001-2010		
AirTran	Frontier[2]	Southwest Airlines
Allegiant[1]	JetBlue	

[1]: 2002-2010
[2]: 2001-2009

In the post-2001 era LCCs have been forced to reassess their business models and make adjustments to react to broad economic and industry downturns, increased competition from carriers with new and innovative business models, and respond to changing customer, industrial, and technological aspects, which is reflected in the emerging disparity among their business models (Franke, 2007). The qualitative nature of business models challenge measurement of their various aspects. Alamdari and Fagan (2005) and Osterwalder (2004) attempt to incorporate business model measurement and comparison within the airline industry, however none incorporate a longitudinal study that identifies which business model activities contribute to profitability. Both Alamdari and Fagan and Osterwalder utilize a Likert scale measurement of business model activities. While Alamdari and Fagan analyze LCCs the analysis studies the degree of business model adherence and profitability implications, Osterwalder proposes a business model comparison of LCCs and FSCs on a similar Likert scale; however, application of this methodology would only identify which business model elements are perceived superior by the two contemporary models.

Quantitative measurement is challenged by the inherent composition of immeasurable aspects of the business model. Ragin's (1987; 2000) qualitative comparative analysis (QCA) is a tool to bridge the gap between quantitative and qualitative research by utilizing Boolean algebraic techniques to determine algebraically which combination of presence and absence of independent variables is necessary to produce a desired outcome. The method is often praised for its ability to perform analysis of parts across cases without losing focus on the whole, as this study analyzes independent business model activities to propose a successful model (Miles & Huberman, 1994). QCA is useful for comparing qualitative phenomena that are difficult to measure on interval scales. The concept incorporates binary data to measure both dependent and independent variables; 1 indicates presence, while 0 indicates absence. Data is presented in a matrix, known as a truth table, which displays a reduced representation of binary interpretation data. QCA utilizes algorithms to analyze the truth table and produces a minimization equation that results in the presence of the dependent variable. The minimization expression utilizes Boolean algebra: an addition symbol (+) means logical "or", while multiplication symbolizes logical "and." An uppercase letter indicates presence, while a lowercase letter indicates absence; in other words, the minimization combination "Ab + BC" is the expression for presence of "A" and absence of "b" or presence of "B" and presence of "C" which results in the outcome of the dependent variable. The author utilized TOSMANA (Tool for Small-N Analsysis), a QCA software program to perform the algorithm (Cronqvist, 2011). Although QCA was initially utilized in political science research, it has recently found its way into a range of study areas, for example human resources (Coverdill & Finlay, 1995; Romme, 1995) tourism and purchasing behavior (King & Woodside, 2000), and consumer segmentation (McDonald, 1997).

QCA allows the author to perform business model cross-case analyses of the selected airline study groups on a time-series basis as an aggregate. The intent of the analysis is to investigate which combinations of business model activities are necessary to achieve operational profitability, and to analyze the Boolean technique as an analytical tool. Operational profitability, rather than net profitability, is used as a dependent variable as it more accurately demonstrates the effectiveness of airline operational activities, which reflects the chosen business model. While an airline's net profit incorporates non-airline related charges, the operational profitability measures the financial sustainability of the airline's core activities.

The analysis occurred through a four-step process. The initial step required the identification of business model activity activities, which was completed following a thorough review of the literature and screened for elements that were immeasurable or incompatible with binary notation. The business model elements: target market, value proposition, network and financial review were omitted from the analyses due to challenges with binary notation and lack of innovative rigor. The coding of each business model element for the selected study group and data period followed. The third step requires the creation of a truth table displaying the coded results. The final step in the process includes performing the algorithm, minimizing, and analyzing the Boolean results.

Results

A review of the airline business model literature presents 10 independent business model activities that have an impact on operational profitability (Alamdari & Fagan, 2005; Bieger et al., 2002; Bieger & Agosti, 2005; Taneja, 2004), which were presented in section 1. Binary coding of the independent variables is presented in the truth table in table 3.

Table 3:
2001-2010 Boolean LCC truth table

Conditions										Profitability	Frequency
A	B	C	D	E	F	G	H	I	J		
0	1	1	1	1	1	1	0	1	0	1	4
0	1	1	1	0	1	1	0	1	0	--	6
1	1	0	1	1	1	1	0	0	0	1	5
0	1	0	1	0	1	1	0	0	0	0	1
0	1	0	1	0	1	1	0	1	0	0	1
0	1	0	1	1	1	1	0	1	0	0	3
1	1	1	1	1	1	1	0	0	1	--	8
1	1	1	1	1	1	1	0	1	0	0	1
0	0	0	0	0	1	0	0	1	0	--	9
0	1	0	1	1	0	1	0	0	1	1	2
0	1	0	1	1	0	1	0	0	0	--	8

0 = condition absence
1 = condition presence
A = Interline connections
B = Online connections
C = Ticket restrictions
D = Through-fares
E = GDS distribution
F = Single class cabin
G = FFP
H = Lounge access
I = Single fleet
J = Regional airline feed
-- = Contradiction (both positive and negative profitability are present)

There are 1042[3] unique combinations possible with 10 independent variables and binary notation, however the longitudinal truth table shows only 11 unique combinations. This is a reflection of the limited diversity found among US LCC business models, which deviate narrowly from the traditional business model, a result similar to Alamdari and Fagen (2005). Limited diversity places constraints on testing causal arguments; however it is also testimony to the social forces that have helped to shape the industry (Ragin, 1987). In QCA, assumptions regarding populations and dependence on samples are avoided because cases are handled as interpretable combinations of characteristics and not as sample values. The frequency (f) of occurrences has no bearing on the minimization computations; they are shown to remind the reader that each combinational line is not a single case but a collection of cases. It is shown in the truth table that there are 3 distinctive business models that lead to operational profitability greater than the sample period's median. These models differ in their activities in ticketing, amenities, and organizational activities. In addition, there are 4 business models that create contradictory results, both positive and negative. Contradictions can be solved by adding more distinguishing activities to the analyses or creating different thresholds in the binary coding.

[3] $2^{10} = 1042$ combinations

Application of the Boolean minimization algorithms of the Tosmana software (Cronqvist, 2011) to the truth tables in table 3 results in the logically minimal reduced Boolean expressions for instances of operational profitability excluding fuel among US LCCs in a time series, which are presented in table 4.

Table 4:
Boolean minimization table for 2001- 2010

Alternative	Business model activities
1	interline * ONLINE * TICKET RESTRICTIONS * THROUGH FARES * GDS DISTRIBUTION * SINGLE CLASS CABIN * FFP * lounge access* SINGLE FLEET * regional airline feed
	+
2	INTERLINE * ONLINE * ticket restrictions * THROUGH FARES * GDS DISTRIBUTION * SINGLE CLASS CABIN * FFP * lounge access* single fleet * regional airline feed
	+
3	interline * ONLINE * ticket restrictions * THROUGH FARES * GDS DISTRIBUTION * single class cabin * FFP * lounge access * single fleet * REGIONAL AIRLINE FEED

Capital letters = activity present
Lowercase letters = activity absent
Multiplication (*) = and
Addition (+) = or

These reduced equations state which combination of business model activities, both present and absent, lead to an operational profitability excluding fuel that exceeds the median operational profitability during the past decade. Combinations of minimized expressions depicting both a present and absent element require that all conditions are met. While there are airlines in the study group that achieved profitability with dissimilar business models, there are others that posted losses with the exact same models; therefore, it can be stated that this model does not consistently lead to positive results. There is a core combination of activities that does not vary among the three alternatives: a presence of online ticketing, through fares, GDS distribution, FFP, and lack of lounge access. This implies that LCC carriers should have this combination of business model activities, regardless of which other alternatives they choose among the remaining activities. This core combination is in stark contrast to the traditional LCC business model. Online ticketing may have allowed LCCs to expand their network reach and attract new customer segments bringing in additional revenue without the excessive added cost. This activity change also explains the through-fares that LCCs should offer to complement online ticketing. Distribution via GDS systems is also an activity that goes against the traditional LCC model. This form of distribution is more costly, however has a broader reach with business customer segments. The US LCC sample group though has a longer history than counterparts in other regions. This history may have implications on GDS presence. Frequent flyer programs are the final core activity that is present in the three alternatives. This activity is not traditionally found in the LCC business model, however allows LCCs to appeal to loyal customers. The final activity that is found throughout the table is the lack of lounge access. One is challenged to conclude which of the three alternatives is most similar to the traditional LCC business model. Each replicates some part of the traditional business model, yet stands apart in its entirety. The range of the core combination of activities may be a sign the traditional LCC business model is under transformation and that the model is adapting itself to appeal to broader customer segments.

Method critique

QCA is a new methodology introduced to the fields of business model innovation and airline literature. QCA allowed longitudinal analyses and was successful in identifying which combination of business model activities that LCCs can innovate in an attempt to improve financial performance at the operational level. In addition, the method addressed the challenge of a quantitative study of qualitative elements. The truth table and minimization results were reliable, however a QCA limitation exists if the dependent variable is both present or absent all of the case studies. The algorithm is unable to minimize such combinations and results will not be forthcoming. Suggestions for future research include expansion of the sample group to include other regions and measure cases at the quarterly level. The QCA method can be improved utilizing multi-variant QCA (MVQCA), which allows the researcher to incorporate scale measurements rather than dichotomous denotation. However, the results produced with the QCA algorithm are useful and the methodology may be strengthened by a larger scale study.

Conclusion

The airline industry is entering a new era of business model innovation as regulatory, technological, and market changes force airlines to continuously revamp their business models in an attempt to create a competitive advantage. There are numerous factors that comprise the airline business model, however the activity set of airlines is where the majority of innovation occurs. Past research has failed to propose which activities require an innovative touch; however, with application of Boolean algorithms it is possible to focus innovative attention. Those business model activity combinations that contribute to positive operational profitability are a core combination of a presence of online ticketing, through fares, GDS distribution, FFP, and lack of lounge access, along with a variety of five other activities at the airline choosing. As the industry progresses and more business model innovation occurs new activities must be identified that can contribute to profitability.

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