

Strategic Choices of an Entrepreneur Using Statistical Decision Theory

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Abstract

This paper addresses the strategic decisions in a start-up using statistical decision theory. While considerable progresses have been made in the development of statistical decision models, little attention has been paid to applying them in the "real world" mostly in the entrepreneurship. Three points are demonstrated on the basis of results: the importance of using scientific tools to decisions making, mainly at the initial stage of a venture; the use of payoff matrix provided structure to the necessary elements to select that strategy that guarantees the greatest benefit for the entrepreneur, all on the basis of previous research; the use of these tools is an advantage for those who want to start a business and want to pass over a decision based solely on intuition and the apparent perception of a market opportunity; and the awareness by the entrepreneur about the importance of deepening the information needed to make decisions and use of tools to process it.

Keywords: Entrepreneur, statistical decision theory, strategic decision making, management.

1. Introduction

The most important decision of an entrepreneur is the intentional act to select the strategy to launch and manage his business (Artinger & Powell, 2016; Farsi, Nouri, & Kafeshani, 2016; Forbes, 2005; Frese, Gelderen, & Ombach, 2000) when faced with entrepreneurial opportunities (Miao & Liu, 2010; Wei & Hisrich, 2016). Decision theory is the science of making optimal decisions in the face of uncertainty (Berger, 1989), but unfortunately in case of entrepreneurs, decision making in not always support it by a previous analysis and robust tools that bring a relative reliability to the final decision even when a very large and growing fraction of people in business struggle with such decisions every day (Sarasvathy, 2001). Many times rush, lack of adequate and sufficient information, dynamicity, uncertainty and ambiguity of the environments under which entrepreneurs act, propitiate irrational and hasty decisions, particularly in the initial phases of their businesses (Bager, Klyver, & Nielsen, 2015; Busenitz, 1999; Farsi, et al., 2016; Frese, et al., 2000). Given the importance on making accurate decisions under ambiguous conditions is possible to find an impressive body of work on entrepreneurial decision making, turning this topic of great interest to entrepreneurs (Busenitz, 1999; Sarasvathy, 2001; Shepherd, Williams, & Patzelt, 2015; Wood & Williams, 2014).

Decide which is the better strategy to be successful is a crucial strategic decisions that have to be very well analyzed in order to guarantee the subsistence of the new business in the market (Bager, et al., 2015; Brush, Greene, & Hart, 2001). In this context rational decision making need indispensable information as well as enough time and people to process and analyze them, but making an "optimal" choice is not always possible, for that reason decision makers aim for "satisfactory" choices, also known as the bounded rational decision model (Huppertz, 2015; Simon, 1997; Wennberg, Delmar, & Mckelvie, 2016). What is true is that "founders of new ventures always follow some strategy to reach their goals, though these strategies are not always highly rational or explicit" (Frese, et al., 2000, p.1). Strategy is defined by a plan of appropriate actions in uncertain situations, that is, a sequence of means to achieve a goal (Hacklin & Wallnöfer, 2012; Mintzberg, Lampel, Quinn, & Ghoshal, 2003; Rivkin, 2001; Thompson, Gamble, Peteraf, & Strickland, 2012).

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Strategic options in a small start-up firms rarely are simple but this is not an excuse to refrain from taking decisions of a particular course of action mostly when the decision are likely to impact future choices such as market behaviors, resource acquisition, funding and growth perspectives, taking into account the expectations about the future of the new venture (Brush, et al., 2001; DeTienne, McKelvie, & Chandler, 2015). When the strategic choice provide a good differentiation of the startup in its market they become a unique advantage for the organization but this depends, among other thing, on "how entrepreneurs perceive environmental conditions, including uncertainty and market conditions, and these differences affect decisions related to entrepreneurial opportunity" (McKelvie, Haynie, & Gustavsson, 2011; Shepherd, et al., 2015, p. 16). In this context is possible to find several studies relates with the use of decision-making techniques or "tools," and its impact on the strategic decision to a new venture (Krueger, Reilly, & Carsrud, 2000; Patel & Fiet, 2009; Shepherd, et al., 2015).

The objective of this work is to use the Statistical Decision Theory, as a framework for inference for any formally defined decision-making problem, in the decision making of an entrepreneur in relation of his entry strategy to the market trying to minimize biases in their decision making, although the authors recognize that the results could be influenced by the natural tendency of the entrepreneur to expect positive future outcomes even when such expectations are not rationally justified (Cassar, 2010; Hmieleski & Baron, 2009; Shepherd, Haynie, & McMullen, 2012; Wennberg, et al., 2016). Anyway the opportunity is to help business founders use information to move beyond the realm of 'just seeing the facts that fit' to a higher standard of improved decision quality that leads to wiser decisions. In addition, this paper aspires to contribute to the entrepreneurship providing early-stage of entrepreneurial activity a way to make decisions that are more robust.

2. Statistical Decision Theory

Identify an opportunity is a necessary step but still insufficient for entrepreneurial action, subsequent to the identification of an opportunity, entrepreneurs must evaluate the opportunity as they decide whether or not to act and which strategy will follow to take advantage of it (McMullen, 2015; Wood & Williams, 2014). The practice decision making, including strategic analysis, evaluation, and strategic choice (Forbes, 2005; Hacklin & Wallnöfer, 2012). In these steps uncertainty or risk is always involve and a typical problem in statistical decision theory combines aspects of both, that is what makes Statistical Decision Theory pertinent, because "is concerned with the making of decisions when in the presence of statistical knowledge (data) which sheds light on some of the uncertainties involved in the decision problem" (Berger, 1989, p. 217).

Statistical Decision Theory is "a formal attempt at providing a rational foundation to the way we learn from data" (Parmigiani, Inoue, & Lopes, 2009). The integration in the analysis of the uncertainty and risk that involves the process of selecting a strategy to launch a venture and the ability of the entrepreneur to interpret this uncertainty and risk is an advantage that provides the application of Statistical Decision Theory preventing errors in the long term (Artinger & Powell, 2016; Berger, 1989; Pun, 2014; Stoye, 2012). On the other hand, Statistical Decision Theory allows that an entrepreneur "makes choices based on her pre-existing knowledge as well as all possible information related to the problem at hand. To arrive at a decision, the individual conducts a search process to identify and analyze alternative approaches and selects one with the highest expected return" (Maine, Soh, & Santos, 2015, p. 55). This behave is very accepted when failure is not an option because of the financial investments, career opportunities, family relationships, personal wealth, and psychic well-being involve in decision (Busenitz, 1999). As is probe it in practice a high percentage of emerging entrepreneurs do not make it to an operational enterprise and high proportion of new startups survive just few years and are not successful in the long term (Artinger & Powell, 2016; Lukeš & Zouhar, 2016; Parker & Belghitar, 2006) so, given the societal consequences associated with failures of decision making in entrepreneurship it is worth investigating decision tasks in this domains (Trommershäuser, Maloney, & Landy, 2008).

In Ecuador, "the low survival of a large number of early entrepreneurs can respond to quality problems of enterprises or efficiency of the ecosystem to strengthen them or both. It is therefore important to consider carefully the entire business development process in the country." (Lasio, Caicedo, Ordeñana, & Izquierdo, 2016, p. 38). In 2015, "7.1% of entrepreneurs said they had closed a business in the last 12 months and although this percentage is 2 points below that observed in 2014, exceeds the regional closing rate for established businesses (5.1%), highlighting the difficulties of survival of the early ventures" (Lasio, et al., 2016, p. 38). The main reason for closing a business in 2014 was "the business was not lucrative". This remains similar in 2015 "may be related to the maturity to undertake, or maturity of the idea" (Lasio, et al., 2016, p. 44).

3. Method

One situation that makes it difficult to make a decision is one in which the consequences of the decisions cannot be controlled, but are subject to randomness; this randomness comes from (1) the process can be governed by chance and (o) (2) lack of information that prevents determine exactly what those consequences are. The context of this work is that in which our decision maker, a local entrepreneur, has to choose among a set of actions (A) and its generic member called a , whose consequences depend on some unknown state of the world, or state of nature (Θ) with generic element. The basis for choosing among actions is a quantitative assessment of their consequences. Because the consequences also depend on the unknown state of the world, this assessment will be a function of both a and θ . So far, we worked with utilities $u(a(\theta))$, attached to the outcomes of the action. Those are the elements involved in a decision process (Eidman, Dean, & Carter, 1967; Lessa, Caous, Arantes, Amaro, & Souza, 2008; Savage, 1951):

$\Theta = \{\theta_1, \dots, \theta_m\}$: The set of states (of nature). This is a set of unknowns, which we would like to determine or estimate.
 $A = \{a_1, \dots, a_n\}$: The set of possible alternatives, decisions or actions. This set is the set of decisions about the state. Elements in a would typically correspond to elements in θ .

u_{nm} : The cost function, consequence between decisions a_n and states θ_m . In order to be able to talk about optimizing the decision is necessary to quantify the cost incurred from each decision.

p_m : The set of observations. Sometimes the odds are also involved in making a decision, the probability that the state θ_m is given; this value often is not known.

Ambiguity or uncertainty obtains when the outcomes corresponding to different actions are uncertain in a manner that cannot be described by a probability distribution. This contrasts with risk, for which a probability distribution is available or they have been estimated (Stoye, 2012; Wennberg, et al., 2016). So, if subjects are given the probabilities then they are making 'decisions under risk', if not, they are making 'decisions under uncertainty' (Trommershäuser, et al., 2008). In this case, the analysis will be related with both situations. In order to make the right decision, is necessary to understand the consequences of taking an action under the uncertainty or risk. The main goal of the decision-making is to find an action which incurs the least loss.

With the mentioned elements, when the process is defined in a single step as the present case, that is, there is only one decision to make in a given time, and sets of states and alternatives are finite, to facilitate understanding of the situation, the problem is represented by a decision table, also known as payoff matrix:

		Θ			
		θ_1	θ_2	...	θ_m
		p_1	p_2	...	p_m
A	a_1	u_{11}	u_{12}	...	u_{1m}
	a_2	u_{21}	u_{22}	...	u_{2m}

	a_n	u_{n1}	u_{n2}	...	u_{nm}

The greatest difficulty in this context is how to value a decision or alternative to compare it with others. For this reason criteria for assessing alternatives are require and, based on the adopted criteria, decide the optimal decision:

Δ : The set of decision rules. The criteria are classified according to the use or not of the probabilities of the different states of nature.

To solve this kind of problem WINQSB2 software was taking into account. WinQSB2, developed by Dr. Yih-Long Chang, is an interactive system that helps decision-making. The software contains very useful tools to solve different types of problems. The system consists of several modules, one for each model type or problem. Among them we highlight the Decision Analysis (DA) that solves problems related with payoff table analysis among others, for that reason, the decision rules explained here respond to the alternatives this software propose at its option dedicated to Decision Analysis. Tables1 and 2below shows a summary of the different criteria to be used:

Table 1. Criteria without Knowledge of the Probabilities of the States of Nature.

Criteria without knowledge of the probabilities of the states of nature (uncertainty)	Problem	Criterion works as follows
Wald's maximin criterion (pessimistic): the decision – maker choose the maximum of the minimum payoff values.	maximum	$Max_i Min_i u_{ij}$
	minimum	$Min_i Max_i u_{ij}$
Maxima criterion (optimistic): the decision – maker choose the maximum of the maximum payoff values.	maximum	$Max_i Max_i u_{ij}$
	minimum	$Min_i Min_i u_{ij}$
Laplace's Equal likelihood criterion (insufficient reason): the decision – maker choose the maximum of the average payoff values.	maximum	$Max \left\{ \frac{i}{n} \sum_{j=1}^m u_{ij} \right\}$
	minimum	$Min \left\{ \frac{i}{n} \sum_{j=1}^m u_{ij} \right\}$
Savage's Minimax regret criterion: the decision – maker choose the minimum of the maximum regret values.	-	$Min_i Max_i \theta_{ij}$
Hurwicz criterion: the decision – maker choose the maximum of the weighted maximum and minimum payoff values.	maximum	$Max h_i = \infty Max u_{ij} + (1 - \infty) Min u_{ij}$
	minimum	$Min h_i = \infty Min u_{ij} + (1 - \infty) Max u_{ij}$

Table 2. Criteria Using the Probabilities of the States of Nature.

Criteria using the probabilities of the states of nature (risk)	Problem	Criterion works as follows
Expected value: the decision – maker choose the maximum of the expected payoff values.	maximum	$\max_i VE = \sum_{j=1}^n u_{ij} * p_j$
	minimum	$\min_i VE = \sum_{j=1}^n u_{ij} * p_j$
Expected regret value: the decision – maker choose the minimum of the expected regret values.	-	$\min_i VE(a_{ij}) = \sum_{j=1}^n u_{ij} * p_j$
Expected value of perfect information (EVPI): it is the difference between expected value with perfect information and expected value without perfect information.	-	$GEIP = \sum_{j=1}^m u_j^* * p_j$ $EVPI = GEIP - VE$

4. Results and Discussion

A young entrepreneur wants to determine the most appropriate strategy in terms of number of rooms, for the creation of a university student residence in the neighborhood of the Equinoctial Technological University, Santo Domingo de los Tsáchilas. The entrepreneur has the idea that this project will benefit largely the foreign student sector that requires proper lodging for a good academic, mental and physical performance due to technological and architectural contribution that this project aims to offer. The project is justified from the point of view of population growth because since 2010 population growth began to rocket in the Tsáchilas province. This population increase is equally palpable in several neighboring cities.

As the population has been growing, there was an increased supply and demand in education. Several universities chose open their extensions in the city of Santo Domingo, opening the opportunity to obtain a higher degree without having to travel outside the city in some cases, and making ease for others, from the neighboring provinces of Manabí, Los Rios and Esmeraldas, not to travel long distances to study. All this brings the effect of increasing flow of students needed for accommodation and food.

In this sense, a study of competition held. At Santo Domingo, there are several alternatives of accommodation: hotels, inns, motels, residential, rental of rooms, apartments, houses and even host families. The investigation could corroborate that these facilities do not meet the expectations of a university residence; the most common causes are: distance from the university where the student is enrolled, high prices, short stay times, and no conditions to study. Students enrolled at the Equinoctial Technological University expressed most of the complaints. During the start-up process information becomes available about the need for the creation of a student residence, attitude toward living in a student residence, customer needs, customer willingness to pay, resource availability and how the studies are funded, and demographic characteristics of potential customers. A survey was applied to 350 students ($p=q=50\%$; $Z=2$; $e=5\%$), the results were as follow in Table 3:

Table 3. Results of the Survey Applied to 350 Students.

Santo Domingo is a City With Lots Of Students with Accommodation Needs. With this Statement, You Are...					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	288	82,3	82,3	82,3
	Agree	40	11,4	11,4	93,7
	Disagree	13	3,7	3,7	97,4
	Undecided	7	2,0	2,0	99,4
	Strongly Disagree	2	,6	,6	100,0
	Total	350	100,0	100,0	
Is the Creation of a Student Residence in Santo Domingo Consider Necessary?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	258	73,7	73,7	73,7
	Agree	64	18,3	18,3	92,0
	Undecided	14	4,0	4,0	96,0
	Disagree	12	3,4	3,4	99,4
	Strongly Disagree	2	,6	,6	100,0
	Total	350	100,0	100,0	
Would you be Willing to Live in a Student Residence?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	178	50,9	50,9	50,9
	Strongly Agree	92	26,3	26,3	77,1
	Undecided	59	16,9	16,9	94,0
	Disagree	16	4,6	4,6	98,6
	Strongly Disagree	5	1,4	1,4	100,0
	Total	350	100,0	100,0	

As is possible to observe there are high percentage of acceptance in relation with de student residence at the location. The proposed university student residence can reach a capacity of 100 students (50 rooms). It will latch on its own grounds (12,000 square meters) of family use, 50 meters from the Equinoctial Technological University. Each room will have an area of approximately 20 square meters and maximum capacity of two persons per room. It will be fully equipped for the requirements demanded by potential customers, summarized in the Table 4 below:

Table 4. Requirements Demanded by Potential Customers.

Component Matrix ^a	Component		
	1	2	3
	Hygiene	Comfort	Location
Permanent water	,810		
Security		,983	
Laundry	,745		
Affordability		,896	
Comfort facilities		,852	
Cable Service		,768	
Comfortable rooms		,756	
wifiservice		,725	
Nearthetown			,781
Nearness of the university where I study			,566
General cleaning	,691		
Interior bathroom		,720	

Extraction Method: Principal Component Analysis
Método de rotación: Varimax con normalización Kaiser.
3 componentes extractad.
Kaiser-Meyer-Olkin Measure of Sampling Adequacy = ,872
Sig. Bartlett's Test of Sphericity = ,000
Total Variance Explained = 88,832
Alfa de Cronbach of the scale used = ,885

For the above is set as service strategy to base the operation of the residence on three fundamental elements, hygiene, comfort and location. In relation with the price, information needed to calculate de cost function, the results obtained are in Table 5:

Table5. Results Obtained About Information needed to calculate de cost Function.

How much would be willing to pay per month to live in a student residence?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	\$80.00 to \$100.00	288	82,3	82,3	82,3
	\$101.00 to \$120.00	58	16,6	16,6	98,9
	\$121.00 to \$150.00	4	1,1	1,1	100,0
	Total	350	100,0	100,0	

In order to a better comprehension of the data collected, a cross tabulation was develop. The result shows below in Table 6:

Table 6. Results a cross tabulation developed.

Would you be willing to Live in a Student Residence? * How Much would be willing to Pay Per Month to live in a Student Residence? Crosstabulation					
Count	How much would be willing to pay per month to live in a student residence?				
		\$121.00 to \$150.00	\$101.00 to \$120.00	\$80.00 to \$100.00	Total
Would you be willing to live in a student residence?	Strongly Agree	1	17	74	92
	Agree	1	29	148	178
	Undecided	0	10	49	59
	Disagree	2	2	12	16
	Strongly Disagree	0	0	5	5
Total		4	58	288	350

Asymp. Sig. (2-sided) for Chi-Square Tests: ,007** (the variables are not independent)
Symmetric Measures: Phi: ,244; Cramer's V: ,173; Contingency Coefficient: ,237, (not very strong relationship)

These results will be used further as the information relate it with the state of nature. Given that the main business income corresponds to the paying customers for the use of the rooms, and the need to take a competitive price for business in the area, the entrepreneur faces the dilemma of deciding what pricing strategy adopt. The entrepreneur has determined that fail rented rooms will make him incur in a maintenance cost of 10 USD per month. With the information gathered was possible to shape the pay matrix that follows in Table 7:

Table 7. Pay Matrix.

Amount of potential clients		⊖		
		Behavior according to the agreement	Behavior according to the indecision	Behavior according to the disagreement
		77,1%	16,9%	6%
A	\$80.00 to \$100.00	222	49	17
	\$101.00 to \$120.00	46	10	2
	\$121.00 to \$150.00	2	0	2

Incomes expected		⊖		
		Behavior according to the agreement	Behavior according to the indecision	Behavior according to the disagreement
		77,1%	16,9%	6%
A	\$80.00 to \$100.00	10000.00 (50 full rooms)	4650.00 (4900.00 income less 250.00 of maintaining cost of 25 rooms empty)	1290.00 (1700.00 income less 410.00 of maintaining cost of 41 rooms empty)
	\$101.00 to \$120.00	4330.00 (4600.00 income less 270.00 of maintaining cost of 27 rooms empty)	550.00 (1000.00 income less 450.00 of maintaining cost of 45 rooms empty)	-290.00 (200.00 income less 490.00 of maintaining cost of 49 rooms empty)
	\$121.00 to \$150.00	-290.00 (200.00 income less 490.00 of maintaining cost of 49 rooms empty)	-500.00 (maintaining cost of 50 rooms empty)	-290.00 (200.00 income less 490.00 of maintaining cost 49 rooms empty)

Final payoff matrix		⊖		
		Behavior according to the agreement	Behavior according to the indecision	Behavior according to the disagreement
		77,1%	16,9%	6%
A	\$80.00 to \$100.00	10000.00	4650.00	1290.00
	\$101.00 to \$120.00	4330.00	550.00	-290.00
	\$121.00 to \$150.00	-290.00	-500.00	-290.00

To help this entrepreneur to make his decision WinQSB 2.0 software was used. The solution to the entrepreneur comes as show Figure 1.

Figure 1: Output Results for WINOSB2

07-01-2016 Criterion	Best Decision	Decision Value	
Maximin	\$80.00 to \$100.00	\$1.290	
Maximax	\$80.00 to \$100.00	\$10.000	
Hurwicz (p=0.4)	\$80.00 to \$100.00	\$4.774	
Minimax Regret	\$80.00 to \$100.00	0	
Expected Value	\$80.00 to \$100.00	8.573,25 €	
Equal Likelihood	\$80.00 to \$100.00	5.313,33 €	
Expected Regret	\$80.00 to \$100.00	0	
Expected Value	without any	Information =	8.573,25 €
Expected Value	with Perfect	Information =	8.573,25 €
Expected Value	of Perfect	Information =	0

07-01-2016 Alternative	Maximin Value	Maximax Value	Hurwicz (p=0.4) Value	Minimax Regret Value	Equal Likelihood Value	Expected Value	Expected Regret
\$80.00 to \$100.00	\$1.290**	\$10.000**	\$4.774**	0**	5.313,33 €**	8.573,25 €**	0**
\$101.00 to \$120.00	(\$290)	\$4.330	\$1.558	\$5.670	1.530,00 €	3.413,98 €	5.159,27 €
\$121.00 to \$150.00	(\$500)	(\$290)	(\$416)	\$10.290	(\$360)	-325,49 €	8.898,74 €

As is possible to see, to the complete uncertainty, a 0.4 coefficient of optimism is proposed. With these results the entrepreneur could make a decision of witch price open strategy he could enter with his start-up in the market. Note that the decision criteria used have led to similar recommendations. Finally the decision to adopt the entrepreneur is the renting strategy with a price of 100.00 USD. In this occasion, the entrepreneur did not face different recommendations based on the criterion used in which case; it would have to select the recommendation that better reflect his expectations based on their experience, intuition and objectives. In this study, we set out to explore how statistical decision theory helps entrepreneurs in decision making. We have seen how the decision-making process for this entrepreneur went through different phases: clarifying the problem, search for alternatives, establishing criteria, choosing an alternative for further implementation and control, stages that were not described in this article.

The application of statistical decision theory allows discuss the decision problem that face the entrepreneur in the early stage of his start-up from different points of view, because as we know out of heterogeneity, different paradigms and perspectives comes out better solutions. However, it cannot be expected from the theory of decision definitive and indisputable solutions, the only thing that can help is with a guide to handle decision-making. As the recommendations derived from the various criteria match, the better, and thenwas possible to choose without hesitation the recommended alternative. It is important to remember that the criteria presented here are specific to the situations described, but other factors (strategic, political, recurrence of the decision, complimentary, opportunity) that affect decision making and should also be considered to ensure the success of the enterprise.

Our results provide valuable practical insights for the entrepreneur and his student residence start-up. With regard to the simplicity of the showed case we find useful that entrepreneurs refine the way they make their decisions, mainly those in the first stages of their venture. This becomes more important if you consider the demonstrated mortality rate of nascent ventures in Ecuador. On the other hand, the study facilitates entrepreneur’s personal growth who did not think it was necessary to investigate so deeply to conduct your business idea.

5. Conclusions

This study sheds light on the important question concerning the use of proved tools in decision making by entrepreneurs mainly at the very beginning of their start-ups. Intuition, experience and sense of business are important asset of every entrepreneur, but sometimes magnify the perception of the market opportunity. The statistical decision theory combines insights from entrepreneur, market behavior, client’s expectations all of which facilitates a deep understanding of the real decision situation, and make a decision. The entrepreneurs that succeed in the use of modern tools as ones related with statistical theory decision will make wiser choices and, act on them to ensure the survival of their start-ups. The use of statistical tools could be very difficult at the very beginning but is necessary a formation process to give entrepreneurs the instruments to make good decisions. Mainly because lots of them, ones they notice what useful could be this tools, are willing to use them because they recognize the benefit of doing that.

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