Learning by Simulation-Computer Simulations for Strategic Management Decision Support in Tourism

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Learning by Simulation

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Computer Simulations for Strategic Management Decision Support in Tourism

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Abstract

This paper describes the use of corporate decision and strategy simulations as a decision-support instrument under varying market conditions in the tourism industry. It goes on to illustrate this use of simulations with an experiment which investigates how successful different market segmentation approaches are in destination management. The experiment assumes a competitive environment and various cycle-length conditions with regard to budget and strategic planning.

Computer simulations prove to be a useful management tool, allowing customized experiments which provide insight into the functioning of the market and therefore represent an interesting tool for managerial decision support. The main drawback is the initial setup of a customized computer simulation, which is time-consuming and involves defining parameters with great care in order to represent the actual market environment and to avoid excessive complexity in testing cause-effect-relationships.

Keywords: simulation models, decision-support systems

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Introduction

Learning and exploring the consequences of alternative managerial decisions works very well in real life, although it may come at a very high price (Lilien & Rangaswamy 1998). One of the most fundamental management decisions is the choice of which market segment to target. The fundamental idea behind market segmentation is that an optimally chosen target segment will enable tourist destinations as well as the industry to adapt their entire marketing mix in order to satisfy this particular group of visitors as effectively as possible, thus ensuring increased sales, higher effectiveness in marketing activities and higher profitability (Fitzgibbon 1987; Middleton 1988; Smith 1995). In addition, market segmentation and product positioning are strongly interrelated and thus determine the long-term orientation of any tourist destination or company (Myers 1996). A suboptimal target segment decision can therefore have long-lasting negative effects on the region, including not only short-term drops in profitability but also a lack of long-term positioning in the marketplace. Imagine a peaceful mountain destination in the Alps that has been appreciated by elderly vacationers for its beautiful landscape and serene environment for decades. Re-orienting this destination toward the family segment – which in itself presents a difficult repositioning task – would cannibalize the original market segment to an unrestorable state. Therefore, managers require tools in order to try out various segmentation decisions before actually implementing the decision on the market and running the risk of doing permanent damage to the destination's image. One possible means of experimentation aimed at gaining insight into the functioning of a system can be found in the computer-simulation approach. Learning by simulating market reactions to marketing activities is a low-risk alternative to expensive real-life trial-and-error approaches (pseudo-experiments) and thus suggests itself as an attractive management tool.

Simulations have been used throughout the tourism and leisure industry in the past, but their purpose and nature was both heterogeneous and different to the simulation concept introduced in this article. Simulation models in tourism can be classified into three broad groups: Most of the simulations models are economic in nature and represent extensions of models based on empirical macroeconomic data (Velthuijsen & Verhagen 1994; Gonzalez 1998; Felsenstein & Freeman 1998; Alavalapati & Adamowics 2000; Smeral & Weber 2000; Jensen & Wanhill 2001). These simulations typically aim to reveal interrelations between tourism demand and multiple influencing factors (such as price level, exchange rate, etc.) and thus allow hypothetical scenarios to be constructed under changing conditions. A second stream of simulation models in tourism is motivated by a need to optimize managerial decisions on an operational basis. These approaches are mainly product-based, and their experiments support management decisions regarding product modifications (Smith, 1994; Sheel 1995; Field, McKnew & Kiessler 1997; Chou & Liu 1998; Duffy, Corson & Grant 2001). Finally, a few researchers have studied the consumer behavior component or included it in broader simulations. Darnell & Johnson (2001) study the impacts of repeated visits and include consumer characteristics in the model. Walker, Greiner, McDonald & Lyre (1998) construct a complex destination model consisting of an economic and a resource requirement model as well as attraction, marketing and visitor-activity models. The latter comprises consumer characteristics such as duration of stay and expenditures.

Although it is widely accepted in tourism marketing that understanding consumer behavior is crucial to both organizational and corporate success, and that such insight is used both in strategic marketing (segmentation and positioning) and operational marketing (product design, pricing, retail strategy, advertising), we have not seen any simulations based on the most fundamental building block in tourism marketing: the customers' perceptions and

preferences. The problems with this kind of study are twofold: First, there is a lack of relevant simulation environments that can be readily adapted for practical application. Second, even if such an environment were readily available, it would not be easy to calibrate the model to mirror the market and competitive environment. Both arguments are rooted in the fact that in a simulation model it is far more complex to mirror consumer or organizational behavior than it is to simulate the development of macroeconomic figures.

In this paper, a marketing simulation tool based on consumer perceptions and preferences is presented in order to emphasize the strategic marketing perspective. In this context, simulation is defined as the analysis of a quantitative model by means of executing a (faithfully) coded representation of it on a computer, necessitated by the fact that closed-form theoretical analysis is often too complex or even impossible. The model is parameterized to fit a specific destination or firm in the tourism industry as encountered in real life by modelling, among other parameters, the number and kind of vacation (or hotel, transportation, etc.) products, the number of competitors in the particular marketplace, and the number and vacation preferences of the potential tourists. In the second step, the competitors are modelled to act as agents in the artificial world. Finally, an experimental design is set up in order to allow the more interesting results of the simulation to be tested, for example whether it makes sense to focus on one target segment alone or to target all tourists.

This article (1) describes the simulation environment (the model of the world) in detail, explaining all parameters that can be changed in order to customize the simulation to specific, real-world tourist market conditions, and (2) illustrates the usefulness of the simulation tool using a case which focuses on the strategic decision of target segment choice from the tourist destination's perspective. Different segment choice strategies compete with each other in a *ceteris paribus* setting, which provides us with insight into the usefulness of complex target segment choice strategies.

Simulating the tourism marketplace

The purpose of the simulation environment (or artificial marketplace, artificial world, world model) is to provide a framework which supports *ceteris paribus* experiments designed to provide insight on how successful certain corporate strategies are in a competitive marketplace. The artificial marketplace used for this application consists of three components: the product, the consumers and the competitors. A detailed description of the simulation environment is provided by Buchta & Mazanec (2001), and its implementation is accessible at http://elrond.ci.tuwien.ac.at/software. Figure 1 gives an overview of the manner in which this world model functions. Due to the complexity of the model (which mirrors consumer-decision heuristics, utility models, cognitive dissonance and numerous other constructs from consumer behavior research), our explanations of the simulation environment will be limited to these three basic components.

---------- FIGURE 1 ----------

- The tourism product around which our artificial world is centered consists of a pre-defined number of attributes (eight in the illustration example) which are perceived by customers (e.g., a number of travel destinations evaluated by the tourists using eight criteria such as safety, friendliness, exclusiveness, expensiveness, family orientation, laid-back atmosphere, etc.). The perception of these attributes is influenced by advertising activities only. This assumption does not mirror the reality of a tourist destination in the long run, but it is an acceptable simplification of the "tourism world", as in this case the product's

components are hardly modifiable and the focus of attention is on those factors which competitors can change easily, such as their advertising message. Of course, it would just as well be possible to include unchangeable attributes.

- The simulated world consists of a pre-defined number of consumers; in this example, 100 tourists were modeled. These customers display heterogeneous preferences with regard to the eight product attributes they perceive. This very well mirrors reality in the tourism marketplace. Some tourists prefer a calm and relaxing destination, while others seek adventure and excitement without being particularly worried about relaxation. Six market segments with different preferences describing the "tourist destination of their dreams" were modeled in the artificial world. The model is based on four latent variables with two manifest destination characteristics as rated by the respondents. The preferences of these tourist groups as well as their relative proportions in the marketplace are shown in Table 1. The product attributes and underlying latent factors are hypothetical and can be adapted to each problem at hand. Each column represents one attribute or latent construct, and each row represents one tourist segment. An 'I' indicates that the dimension is irrelevant to the segment described, whereas 'R' stands for relevant. Thus segment #1 does not care about diversity, excitement, exclusiveness and uniqueness, while they do expect their vacation destination to be romantic, laid-back., friendly and family-oriented. These preferences (or ideas of the perfect destination) remain unchanged throughout the experimental phase. Again, if a simulation is conducted in the interest of long-term development, it might be more suitable to allow preferences to be changed in order to account for differing stages in the family life cycle. Each tourist included in the set of relevant individuals is assumed to take one vacation per year, which means that each "artificial tourist" is assumed to make one buying decision per simulation period.

---------- TABLE 1 ----------

- Four destinations are modeled to compete in the artificial marketplace. They are designed as artificial actors, or agents, representing destination management (e.g., the national tourism organization) and described in detail in the section on destination management agents. In general, these actors make use of various decision rules. By simulating numerous periods of time in this artificial world, it is possible to establish which particular strategies are superior or inferior under given conditions.

The simulation itself is a step-by-step process starting with the decisions made by the destination management agents. The decisions in the sample simulation presented consist of the advertising profile (indicating which attributes are included in the advertising message) and the tourists chosen as the target segment. First, the calculations are carried out for the artificial world (determination of the destination chosen on the basis of a comparison of destination preferences and perceptions of destinations). Then destination management agents receive the results in the form of output variables, including consumer choices (i.e., who booked which destination), an attractiveness ranking of all destinations in the eyes of each tourist, and the beliefs or perceptions of the tourists regarding the eight attributes used. Finally, this data is evaluated and analyzed by the agents and new decisions are made.

Sample simulation: A comparison of segmentation strategies

Simulation question

The question investigated by means of simulation experiments obviously depends on managerial questions; in this example, a typical question from the field of strategic marketing was chosen: Which segmentation strategy is superior under which market conditions? The simulation is thus used to support destination managers either in addressing the entire tourist market or in focusing on a particular homogeneous group of tourists.

Destination Management Agents

Each of the four destination management agents has their own philosophy of behaving in the marketplace, or their own strategy. These strategies – although they are simplifications of corporate behavior – are designed to mirror reasonable and realistic management logic. The model includes one agent who does not follow any particular strategy and thus functions as a benchmark for evaluating the other destination management agents' success.

The benchmark chooses target customers and determines attributes to be advertised completely at random.

The "mass tourist destination" tries to attract as many tourists as possible and thus aims its advertising message at all consumers. This destination's advertising profile is copied from its most successful competitor. The mass tourist destination is thus characterized by two components: the fact that all customers are targeted, and the imitation of a successful advertising profile.

The "special interest destination" seeks groups of individuals who are highly likely to book that destination. For this purpose, the perception data received from the marketplace is partitioned (using the *k*-means algorithm) and the class with the highest number of reservations is chosen as the destination's target segment. The advertising profile is defined by including in the message all attributes perceived by the segment more than 50 percent of the time. By choosing this approach, the special interest destination leverages its own strengths by targeting individuals who are attracted to its offerings.

The "unique selling proposition destination" also segments the market and does not attempt to address all potential buyers. First of all, the analysis covers only those perceptions which are actually bought. Second, attributes are only chosen for the advertising profile if they are not claimed by the (market share-weighted) majority of competitors. The segment to be targeted is chosen by comparing the advertising profile with the perceived profiles of the buyers. Individuals with a maximum mismatch of three items between their perceived profile and the advertising profile are included in the target segment. The maximum permissible mismatch is increased gradually if the number of consumers is too small. The individuals selected in this way are then targeted by the USP destination. The idea guiding this strategy is to build up a perceptual position that strongly differs from that of competitors and to target customers that appreciate such a position.

Experiment Design

The four destinations compete with each other in the artificial world described above. Each simulation has a duration of 30 periods. The simulations are conducted under varying conditions (the independent variables of the experiment), as illustrated in Figure 2.

---------- FIGURE 2 ----------

Segment decision frequency: As market segmentation decisions typically represent a destination's long-term strategic orientation, the destinations do not select a new segment in every period. As the frequency of this segment decision might influence the success of different destinations, simulations are run under the condition that the segment decision is made frequently (every three periods) or only on the basis of long-term planning (every six periods).

Advertising budget: The advertising budget could present a restriction on advertising effectiveness for the mass tourist destination, which chooses to attract all customers. In order to allow for this factor, two advertising budget levels are included in the experimental setup: 100 and 200 monetary units.

Segment size: Finally, the size of the segment is expected to influence the success of focused strategies. Therefore, it is necessary to include scenarios with differing segment sizes. Two case scenarios are modeled, covering segments of equal and unequal size (Table 1).

The experiment was set up as a fully factorial design of the conditions described. With three conditions and two factor levels for each condition, eight different simulations have to be run. In order to allow statistical testing of the outcome, each simulation is conducted repeatedly (ten times). The outcome used as a dependent variable in the experiment is the number of units sold on the marketplace, which can represent the number of times a destination is booked.

Results

The results of all simulations conducted were analyzed on the basis of variance (i.e., we assuming a linear model with total sales as the dependent variable), strategy, and experimental design factors as well as their interactions as explanatory variables. The ANOVA test results are provided in Table 2.

The central question in this example is the first to be investigated: Which segmentation strategy proves superior under what conditions? The ANOVA results suggest the conclusion that both special interest destinations and the USP destination perform significantly better than the benchmark and mass tourist destinations. However, these findings cannot be generalized for all market conditions. If a sufficient advertising budget is available to effectively target a large number of tourists with the message, the mass tourist destination beats not only the benchmark but also both of the destinations which focus on smaller segments. This interaction effect is highly significant, as is the influence of a higher marketing budget in general. The management insight arising from this simulation is that not all destinations even have the option of either following a mass marketing strategy or focusing on specific segments. If the budget is too low to ensure the effective targeting of a very large number of potential visitors, the mass-marketing approach will prove to be an inferior

strategy. In this case, the differentiated segmentation strategy is superior and thus recommended to the destination managers.

The remaining influences expected to render significantly different results in the simulation turned out to be inconsequential (indicated by insignificant ANOVA results). Neither the size of market segments modelled in the simulation environment nor the frequency of re-analysis influenced the success of these artificial agents. The first conclusion can be explained by the fact that the companies (as is the case in the real world) do not have full information about the real homogeneous groups which exist in the marketplace. Instead, they base their partitioning of the market on their combined knowledge of perceptual information and choice behavior. Segments targeted by the firms may therefore be sufficiently large even though (or, conversely, because) the underlying psychographic segment has not been revealed perfectly. The fact that various frequencies of re-analysis have no influence is mainly because consumer-preference segments are not dynamic but static in this simulation environment. Therefore, the competitive advantage of frequent market monitoring cannot be exploited in a meaningful way, thus these two factors do not represent critical market conditions favouring or ruling out certain segmentation and positioning approaches in the experiment's environment.

---------- TABLE 2 ----------

The simulation results are depicted by the box plot in Figure 3. The top row contains the results of the simulation runs with unequally distributed segment sizes, and the bottom row contains those conducted under the assumption that the segments are all of equal size. The remaining experimental design factors are coded above each plot. The plot at the upper left thus gives the results under the assumption that the marketing budget is 100 monetary units and the segment decision is reconsidered every 3 periods. As can be seen in this particular plot, the special interest destination achieves the best sales results under this condition, followed by the USP destination and the benchmark. The mass tourist destination can not keep up with competitors given its low budget, which does not ensure sufficient advertising effectiveness to convince the targeted tourists of the destination's attractive characteristics. The two plots on the right illustrate the opposite situation. With a sufficiently large budget, the mass tourism destination returns superior results and is the strategy which will maximize sales.

---------- FIGURE 3 ----------

Conclusions and future work

Simulations have long been accepted as a useful support tool in management decision-making. In the field of tourism, most simulations either focus on macroeconomic aspects, predicting global tourism flows on the basis of aggregated predictors or modeling a microsystem aimed at operational recommendations to improve the product or service. In this article, a different approach is introduced, employing a simulation constructed on the basis of consumer behavior. Consumer-preference segments with various tastes concerning tourist destinations are included in the world model. They act according to the findings of consumer behaviour research, meaning that they compute the utility of each destination on the basis of an ideal point model which compares perceptions with preferences. These customers' perceptions can be influenced by advertising certain characteristics of a destination. In each period of the simulation, each tourist makes one buying decision, booking with one of the four competitors in the marketplace. This simulation environment allows us to conduct

experiments in which competing destinations or companies with different strategies are present on the market. Including relevant market conditions helps us understand the way in which the marketplace functions, and therefore managerial decisions can be taken in a setting that includes both disaggregate customer behavior and competition, the two most crucial building blocks in strategic marketing decisions.

In order to illustrate the usefulness of this approach, a simple simulation was conducted to identify the circumstances under which destinations targeting the entire tourist population are superior or inferior to destinations that focus on sub-segments with more homogeneous expectations. The results indicate that a generalized answer cannot be provided. Instead, we were able to reveal the heavy interdependence between the segmentation strategy and the available marketing budget. Smaller marketing budgets make concentrated marketing activities more promising and mass strategies more risky, while the mass strategy can be very successful if a sufficient marketing budget is available.

The kind of simulation concepts introduced in this paper still have a number of limitations. Besides the fact that software packages are not readily available, it is extremely difficult and time-consuming to construct a simulation model that mirrors those concepts which most strongly determine the way in which the market functions. A model including all mechanisms that could be encountered in the real world would be too complex to allow us to learn from the results, whereas an excessively simple model would not even support the most fundamental necessary conclusions. For example, pricing was not taken into account in the simulation study because the experiment focused on strategic marketing issues. Nevertheless, the exclusion of pricing in the setting presented here clearly represents a limitation to the findings' applicability to real-world situations.

Future work in this field can follow two different lines of research. On the one hand, a number of follow-up experiments could be conducted using the simulation environment settings as presented; for example, an experiment could be designed to investigate the interrelation of segmentation strategies and pricing strategies in such a market environment. On the other hand, fundamental changes could be introduced to the definition of the market, for example by modeling segment preferences dynamically, so that they change over time on the basis of pre-defined rules or in reaction to advertising efforts in the marketplace. Other fundamental changes in the market setting could include the introduction of dynamic changes in market size or varying consumer-decision rules.

On the whole, computer simulation models doubtlessly involve great effort in the construction and calibration of an artificial world. However, the incentive to make this effort is very strong: Factors influencing market success can be investigated systematically in their dependence on destinations or corporate activities.

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Tables and Figures

Figure 1: The simulation environment

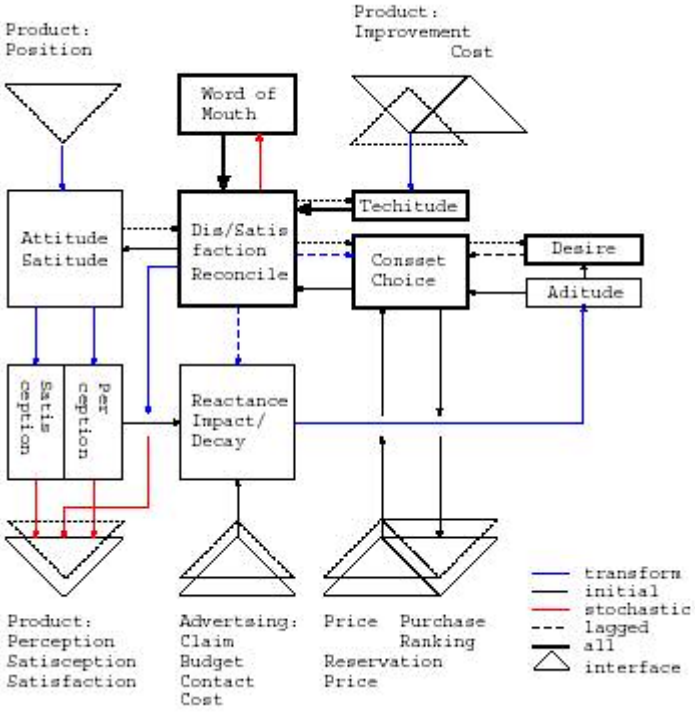

Table 1: Tourist segments modeled in the artificial world

Latent constructs		action		special		comforting		social	
Attributes	(size)	diverse	ex-citing	ex-clusive	unique	romantic	laid back	friendly	family-oriented
Segment 1	10%	I	I	I	I	R	R	R	R
Segment 2	10%	R	R	R	R	I	I	I	I
Segment 2	30%	R	R	I	I	R	R	I	I
Segment 4	10%	R	R	R	R	R	R	R	R
Segment 5	10%	I	I	I	I	I	I	I	I
Segment 6	30%	I	I	R	R	I	I	R	R

Figure 2: Experimental factors (independent variables)

advertising budget (2 levels)	**segment decision frequency (2 levels)**	**segment size (5 levels)**
100 monetary units	every third time period	segments equally sized
200 monetary units	every sixth time period	unequal segment sizes

Table 2: ANOVA results for the experiment with fixed Prices

Type	Variable	Variable	t value	p value
Intercept		Benchmark, segment decision every third period, low advertising budget (100), equal preference segment sizes	19.677	**< 2e-16 *****
Main effect		Segment decision every sixth period	0.708	0.480
Main effect		Large advertising budget (200)	-1.943	**0.053 .**
Main effect		Unequal preference segment sizes	-0.413	0.680
Main effect		Mass tourist destination	8.078	**1.55e-14 *****
Main effect		USP destination	1.574	0.117
Main effect		Special interest destination	5.127	**5.24e-07 *****
First order interaction	Segment decision every sixth period	Mass tourist destination	-0.971	0.332
First order interaction	Segment decision every sixth period	USP destination	0.014	0.989
First order interaction	Segment decision every sixth period	Special interest destination	-1.045	0.297
First order interaction	Large budget (200)	Mass tourism destination	5.662	**3.47e-08 *****
First order interaction	Large budget (200)	USP destination	-0.521	0.603
First order interaction	Large budget (200)	Special interest destination	0.354	0.724
First order interaction	Unequal preference segment sizes	Mass tourist destination	1.277	0.203
First order	Unequal preference	USP destination	0.865	0.388

interaction	segment sizes			
First order interaction	Unequal preference segment sizes	Special interest destination	-0.975	0.331

. Indicates significance at a 90% confidence level

*** Indicates significance at a 99.9% confidence level

Residual standard error: 13900 on 304 degrees of freedom

Multiple R-Squared: 0.6722, adjusted R-squared: 0.656

F-statistic: 41.56 on 15 and 304 DF, p-value: 0

Figure 3: Boxplot of simulation results