Evaluating the impact of decision support on decision markers' performance in marketing. Experiments and development of experimental frameworks on the semantic web.

Mihai CALCIU

Maître de conférences, IAE de Lille

Université des Sciences et Technologies de Lille

104 av. du Peuple Belge, 59043 Lille

Tel: 0320059802

michel.calciu@univ-lille1.fr

Abstract:

This research uses Internet experiments to evaluate the impact of decision support on decision makers' performance in marketing. Two experiments are built around a common positioning (location) problem. The first creates a spatial geo-marketing context and the second is based upon a strategic marketing simulation. Decision support systems adapted to each context intervene as controlled variables. Collected data confirm the hypothesis made and help increase external validity of similar off-line studies, that are replicated in this way.

Our implementations illustrate possibilities and new trends in using the semantic web as an experimental framework for marketing research in general and for inter-cultural studies in particular.

Key words: Experiments, Marketing Decision Support Systems, Internet, Web

Introduction

Internet has changed the way we work, communicate and exchange. It offers an environment that is much more attractive for commerce and business than all preceding communication solutions. Compared to its predecessor, distance sales, electronic commerce substantially shortens the reaction delay during an exchange. The relationship with the customer becomes interactive.

The customer's decision process also changes it gets closer to managerial decision making. In such virtual environment the customer has more choice decisions to take and the environment must deliver support for this information search and choice process.

Studying the impact of Decision Support Systems (DSS) on users is one of the three main DSS research directions that were distinguished by Eom (1995, 1998). It focused first on the study of individual differences and cognitive style and was later reoriented to understand DSS perceived advantage and success factors.

With the diffusion of new information technologies and electronic commerce this research direction extends to Customer Decision Support Systems that become differentiation instruments for the new forms of commerce and proliferate in on-line electronic environments. In order to explore interaction between the customer as decision maker and on-line decision support artefacts, experimentation is a privileged research instrument.

In marketing there are several studies using laboratory experiments in order to explore perceived advantage and success factors of MDSS (Chakravarti, Mitchell and Staelin 1979; McIntyre 1982; Fripp 1985; Goslar, Green and Hughes 1986; Zinkhan, Joachimsthaler and Kinnear 1987; Van Bruggen, Smidts and Wierenga 1996, 1998). A more recent review on this subject can be found in Demoulin (2002).

In this research we use Internet experiments in order to explore the effects of information presentation and DSS on decision making performance in marketing. The main decision problem to solve is generic and regards the positioning or location of “offer units” in a perceptual or geographic space. The competition mechanisms are conceptually the same in the two spaces. Firms compete either in the customers' perceptual space with the image of their products / services or they compete in the geographic space with the image and location of their retail units. The DSS developed and used by us in the two experiments that will be presented exploits the evoked similarity between the two spaces in order to solve with the same algorithms optimum location/positioning problems in a two-dimensional geographic space and in a multidimensional perceptual space.

Certain aspects are integrated from another article of ours Calciu (2003) that illustrates some advantages of Internet experimentations with three examples covering varying marketing domains and varying implementation logic. In contrast this research focuses strictly on decision support aspects. A first experiment deals with solving spatial location problems and have been re-engineered in order to integrate DSS performance measures. The second experiment builds upon the analogy between the location problem and the more general positioning problem in order to implement an on-line strategic marketing simulation as a competitive game. It controls DSS availability and measures decision makers' performance.

The two experiments are “loose” replications of published laboratory research. They are also enriched because transposed on the Internet and completed by new hypothesis, new variables, different implementation modes, different result recording schemes and sometimes different situations. These enrichments didn't change the nature of the original experiments and can still help generalize their results.

Both experiments have produced a first set of results that could be exploited. They are both deemed to evolve towards perpetual on-line experiments that will progressively integrate advances in web application technologies and produce additional results. They are well suited and remain open for inter-cultural studies concerning managerial performance on a European or larger international scale.

Advantages and pitfalls of Internet experiments

In order to understand the strengths of marketing experiments on the Internet, it is necessary to highlight some essential points of the new media's evolution.

Internet established itself from the beginning (in the seventies) as some kind of world computer and brought freedom for data communication and processing. This freedom to interconnect has given experimenters free access to subjects and subjects free access to experiments. At the beginning of the nineties, with the arrival of the World Wide Web (Berners-Lee et al. 1993) a hypermedia (hypertext and multimedia) dimension was added that literally exploded the interest for Internet. Due to URL (Uniform Resource Locator) mechanics that make it possible for hypertext links to access resources distributed anywhere on world wide network, the navigation on the Internet has become a non linear search and query process (Hoffman and Novak, 1996) that produces unlimited freedom of choice and more control on information search for the consumer. Hypermedia brought essential ingredients for implementing on line experiments. For the subjects it eliminated most psychological barriers to access the virtual environment. Web surveys and experiments progressively evolved from simple HTML forms, to client-side applications using JavaScript and Java applets, to server-side applications using first CGI then Servlets, Java Server Pages (JSP) or other server pages technologies. The XML based semantic web by making web page information also machine readable significantly facilitates applications integration over the web and makes it possible to implement experimentation platforms that can easily become more sophisticated than those available in laboratories.

Computer based experimentation has been in use for a long time. Interactivity and multimedia have fostered many nice and powerful experiments. The great difference that Internet brings to experimentation is ubiquity. This ubiquity facilitates application, diffusion and replication of experiments. Internet allows to simultaneously test subjects that are located in different environments and cultures, without spatial and temporal constraints.

One of the first advantages for marketing surveys offered by the Internet is continuity. As to Mahajan and Wind (1999) effective marketing research should engage into a continuous and iterative experimental process similar to the way a physician makes a diagnostic. The first diagnostic, done in real time, leads to a series of experiments. The physician prescribes a treatment and, after having applied the treatment during several weeks, the patient returns. The doctor verifies the effectiveness of the treatment. In contrast in marketing many research projects are viewed as unique events. While experimental diagnostics progress the physician educates the patient on the symptoms to which he must pay attention and on possible treatments. This interactive and iterative process leads to the best treatment. Using this approach marketing research could help customers to formulate their needs and problems or understand and test solutions for a product or service.

Another major advantage offered by the Internet is the possibility to replicate studies. Replication is essential to verify generalisability of results and confers external validity. The importance of replication for insuring external validity to surveys is defended by several researchers (Calder, Phillips and Tybout 1981, Lynch 1982, 1999, McGrath and Brinberg 1983, Winer 1999). As to Lynch (1982, p. 237), for an experimentation to contribute to progress, someone – be it the initiating researcher or others in the field – should try to conceptually replicate it at a certain moment later.

McGrath and Brinberg (1983) insist that it is not possible to increase external validity of a survey by remaining within the framework of the same survey. External validity can only be verified in relation with results from another survey or a series of surveys.

Calder, Phillips and Tybout (1981) make a distinction between effects application research (EA) and theory application research (TA) and underline the importance of external validity for studies belonging to the first category. In effects application research one tries to generalise the results to other situations and populations while in theory application it's the theory itself that needs to be generalised and not particular effects or empirical results. In this case external validity is less important and experimental research should be more concerned with theory-testing and ensuring internal validity.

Reviews of form based experiments conducted over the Internet report surprisingly good results in which Web data match laboratory data for most investigation undertaken (Krantz and Dalal, 2000;

Musch and Reips, 2000). In a research report analysing data from Web-delivered media rich experiments conducted by PsychoExperiment, a public on-line psychology laboratory, McGraw and al. (2000) show that they reveal experiment effects that mirror lab-based findings. “Textbook results are obtained not just for within-subjects effects but for between-subjects effects as well” (idem, p.502). The same authors conclude that the technology is adequate to permit delivery of many cognitive and social-psychological experiments.

Compared to laboratory research that is often constrained to captive and rather undifferentiated population samples (like college students), web research has other three advantages according to Birnbaum (2004, p.813): “On the Web one can achieve large samples, making statistical tests very powerful and model fitting very clean. .. Second,Web studies permit generalization from college students to a wider variety of participants. Third, one can recruit specialized types of participants via the WWW that would be quite rare to find among students.”. At the same time, web studies have several potential problems and disadvantages. In an article that surveys the past literature Cha (2005) identifies four main areas of concern in Internet-based research:

(1) *sampling error and generalizability*: While Internet data collection yields more heterogeneous samples this does not necessarily mean a more representative group of participants that allows accurate generalization to be made from results
(2) *subject fraud*: this includes lying on demographic information or multiple submissions, that are more difficult to control on the Internet
(3) *measurement errors resulting from extraneous factors*: Situations are mentioned where respondents either failed to read the directions on the screen or simply could not figure out what they were supposed to do next. There are also software and hardware compatibility issues that cannot be controlled by the researcher, lack of control over the environmental factors in which participants take part in the study
(4) *the ethics of conducting research on the Internet:* In contrast to traditional research methodology due to the recency of Internet-based research, certain researchers can be tempted to adopt a less ethical behaviour as concerns subject recruitment, protecting privacy of participants, ensuring data integrity etc.

The two experiments presented here try to measure decision making performance by using the same managerial problem in two different contexts. It is the problem of locating and/or positioning a new offer point. The problem is the same whether it deals with the geographic space of retail outlet locations or the perceptual space of brand positions. The integrated decision support systems (DSS) solve this problem using a solution by Calciu and Vermeersch (2003) using algorithms adapted from Drezner (1994).

The presence or absence of such a DSS is a controlled variable in the two experiments that are presented here and serves to verify whether the presence of a DSS influences positively the decision maker's performance in the context of each experiment.

Experiment 1: Effects of problem complexity, information presentation and decision support use on decision making performance.

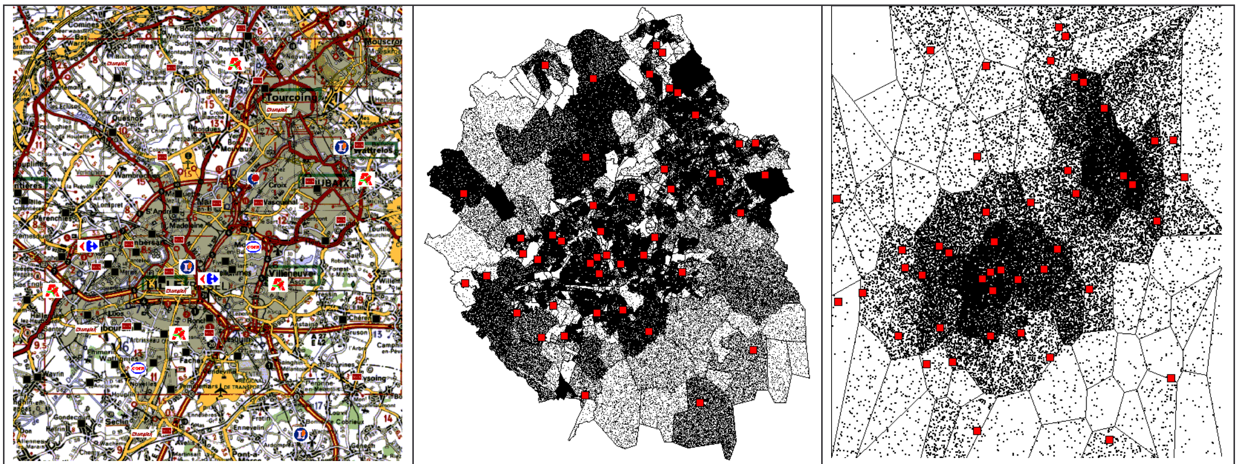
This Internet experiment studies the solution to a spatial location problem. Effects of information presentation and problem complexity on the quality of the given solution are analysed. For these aspects this study follows a research by Swink and Speier (1999). It is not a strict replication as the problem to solve is different and additional effects concerning the use of a decision support system can be investigated.

Subjects in the original study had to determine the number and locations of facilities that minimize the total cost of fulfilling customer product demand. The total cost is the sum of transportation, production, and facility operating costs. Subjects solved these problems using an interactive, menu-driven Geographic Information System (GIS) with integrated decision support.

The problem to solve in this experiment is to find the best location for a new facility (retail outlet) in a two dimensional space compared to the location of other allied and competitor facilities by taking into account the spatial distribution of demand. In marketing this is not only a geographic (geo-marketing) problem or a problem related to processing map-based information, but it is also a brand positioning problem.

The real situation that inspired us was the spatial distribution of hyper- and supermarkets in the one million inhabitants urban agglomeration Lille-Roubaix-Tourcoing in the north of France. A transformation of map-based representation (see figure 1) was necessary in order to eliminate bias that could be induced by an eventual recognition of the places by the subjects and the risk that they could take other variables into account that are not included in the experimental design.

Figure 1. Transformation of a real map situation (urban agglomeration Lille-Roubaix-Tourcoing)



(a) road map with retail chain logos	(b) population dispersion among the 5600 census tracks with retail outlets location	(c) transformed map using Voronoi tessellation on the centroids of aggregated contiguous census tracks

The resulting transformed map in figure 1c, represents spatial offer and demand. The offer points are 47 retail outlets (18 hypermarkets and 29 supermarkets). Demand in the same figure is aggregated in 100 demand areas (Voronoi polygons) and represented by the point density.

A challenge for geographic information presentation is to control inherent complexity of such data laden problems (McMaster and Shea, 1992). The complexity of map-based information comes from different sources like the number of observations and their diversity, the level of aggregation and spatial variability (Burrough, 1992 ; McMaster and Shea, 1992).

Task complexity

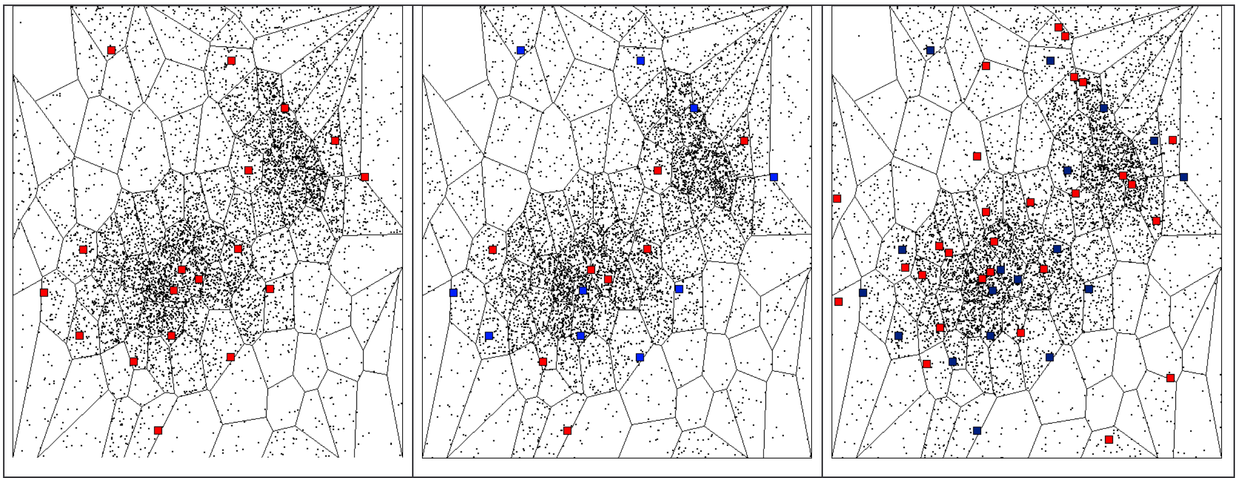
An objective measure of complexity is a function of the number of distinct acts that must be executed and the number of distinct information cues that must be processed when performing a task (Wood, 1986). Campbell (1988) links the complexity of the problem to the maximum number of paths that can lead to the desired result. Uncertainty increases the complexity by increasing the number of potential paths, perceived by the decision maker, towards the desired results. Other researchers have expressed complexity as a function of the number of possible "knowledge states" in a task (Newell and Simon, 1972 ; Card, Moran, and Newell, 1983). For a more thorough discussion and litterature review on measuring task complexity the reader is referred to the original study by Swink and Speier (1999). In this study the task complexity (difficulty) is represented by the dimension of the problem to solve and by taking into account a second distribution network (see figure 2).

Dimension of the problem : A way to increase complexity of a map is to increase the number of data points that need to be examined in order to take a decision. Several studies have shown that for geographic decision tasks the quality diminishes with the number of decisions and knowledge states (Taylor and Iwanek, 1980 ; Robinson and Swink, 1994 ; Crossland et al. , 1995 ; Swink and Robinson, 1997).

The presence of a second network: In order to place a new outlet in a space entirely occupied by competitors the decision maker will intuitively look for locations where there is a relatively better concentration of demand and a relatively low occupation by competitors. When by contrast the space is also populated by allies, the problem gets more complicated, as the decision maker must additionally avoid "cannibalising" his own distribution network. This variable has been introduced by us, and cannot be found in the original study by Swink and Speier (1999).

The resulting hypothesis from this discussion are that increased complexity of the problem worsens the decision quality (H1a) and increases the duration of problem solving(H1b).

Figure 2. Increased task complexity by problem size and adding a second distribution network.



(a) small problem, one network | (b) small problem, two networks | (c) big problem, two networks

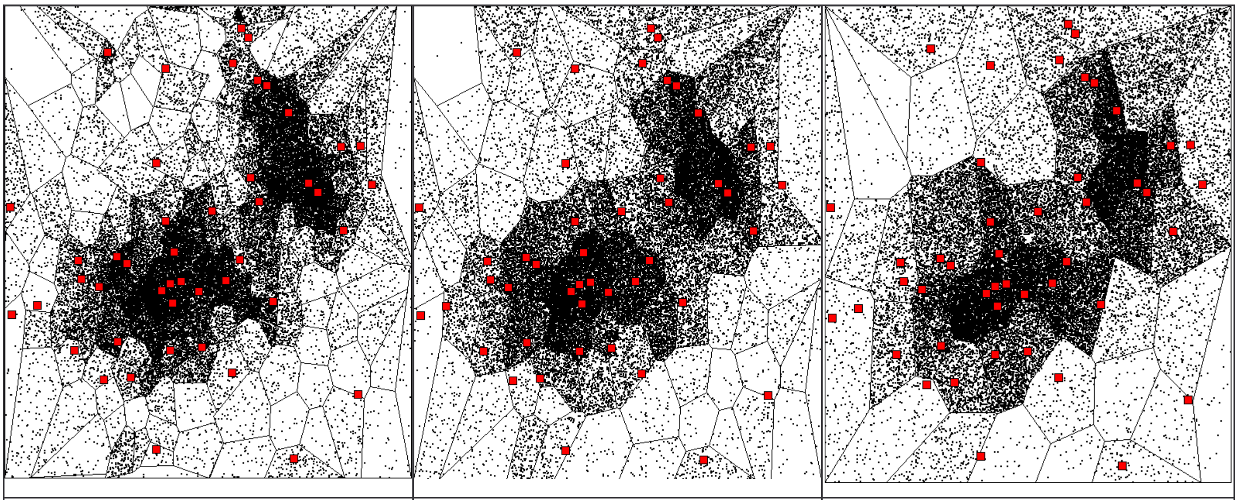
Figure 2 shows how the combinations of different levels of the two variable are represented graphically in the experiment. The small problem displays 18 retail outlet positions (fig. 2a, hypermarkets) all belonging to the competitors. In order to create a two network problem half of the outlets are viewed as belonging to the competitor and the other half belongs to the decision making firm (fig.2b). A big problem displays 47 retail outlets (hypermarkets and supermarkets) and again if there are two networks then one half of the outlets belong to the competitors and half to the acting firm (fig. 2c)

While the variables discussed up to now express problem intrinsic difficulty the next variables represent information presentation artefacts that can help control complexity.

Data Aggregation

Data aggregation level (or the extent up to which data are totalled) is an important decision in map-based information presentation. Aggregation is commonly used to regroup individual data points into geographic clusters. Figure 3 shows the map-based representation of demand aggregated in 200, 100 and 50 areas as used in this study.

Figure 3. Three aggregation levels for demand



a) 200 areas	b) 100 areas	c) 50 areas

Studies on aggregation of tabular data indicate that data aggregation influences directly decision quality (Abdel-Khalik, 1973 ; Barefield, 1972 ; Benbasat and Dexter, 1979 ; Chervany and Dickson, 1974). The data aggregation effect when using map-based information or an geographic information system (GIS) isn't well understood (Swink and Speier, 1999). Taylor and Iwanek suggested that disaggregating the data facilitated problem resolution by enabling decision makers to identify structures or patterns inherent within the map. More information provided by disaggregated data might facilitate greater pattern recognition, heuristic development, or learning. Information load theory comes with opposed conclusions. Disaggregated problems increase information load due to the increased number of information cues that must be processed by the decision maker. Again for a more detailed discussion on this subject the reader is referred to Swink and Speier (1999).

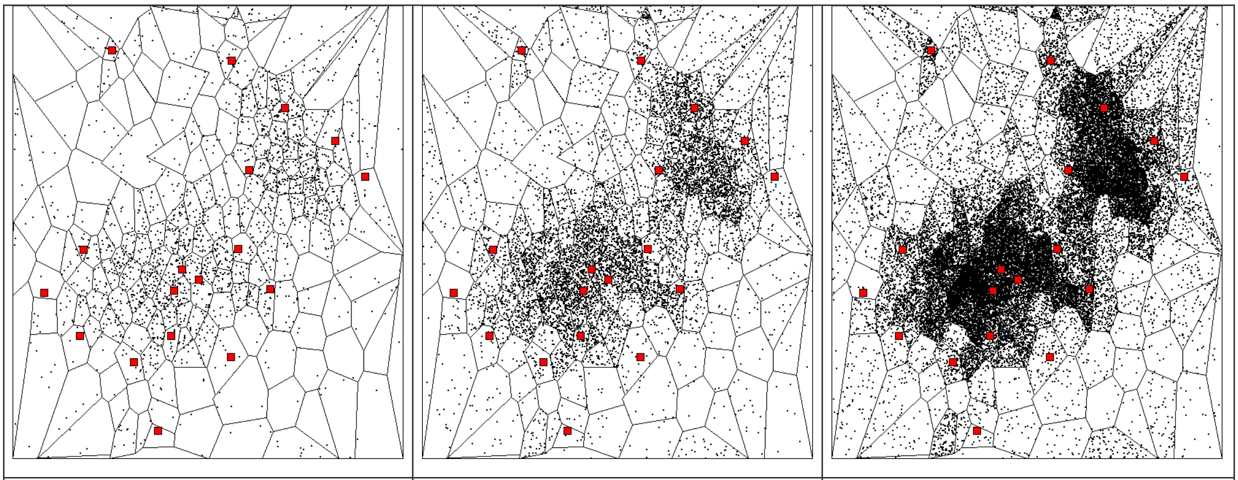
Combining these two theoretical perspectives led us to hypothesis that disaggregating data would improve decision quality up to a point (H2a), but this improvement would engender increased decision time costs (H2b).

Data dispersion

Taylor and Iwanek (1980) have found that solving facility location problems was more difficult when data were uniformly dispersed without apparent groupings. Uniform dispersion dampens eventual discernible patterns while high variation in dispersion reveals them and helps decision making. This leads to hypothesise that high variations in data dispersion produces better solutions (H3a) and reduce decision making time (H3b).

The square root values of the population number in demand areas were used to create the low data dispersion problems (see figure 3a). Similarly population values were squared in order to produce the high data dispersion problems (figure 3c).

Figure 4. Three levels of data dispersion



a) low dispersion	b) medium dispersion	c) high dispersion

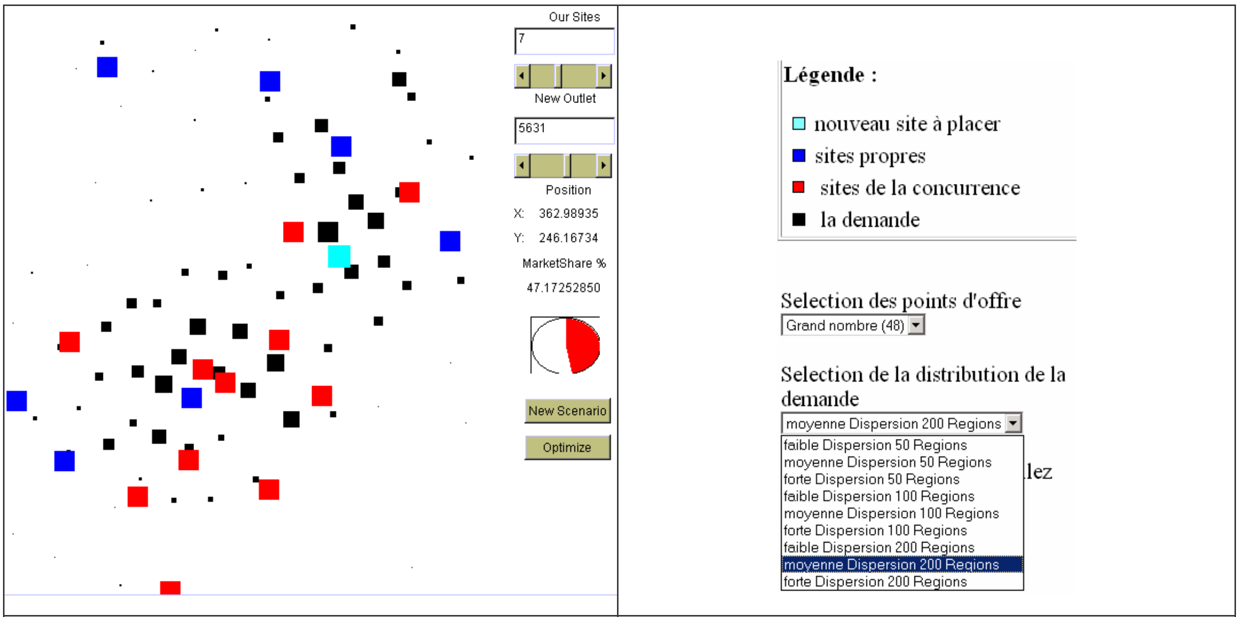
The decision support system

Based upon the optimal location model presented before we have developed using the Java language a decision support system (DSS). The DSS exists in two versions. The first is an applet that comes with a graphic interface that is actionable over the Internet and serves to prepare the decision makers. The second is a command line executable program that produces in "batch" mode solutions to the problems that are generated by changing the values of variables according to an experimental design and allows to evaluate the quality of the decision taken by the subjects participating in this experiment.

The graphic version (figure 5) allows to fix the number of retail outlets that belongs to the own distribution network, indicate the surface of the new outlet and locate it by a simple mouse click. The mouse click launches calculations and displays the market share obtained for the decision maker's distribution network due to the location of the new outlet. The program can also find the optimal location.

Using the DSS in order to prepare subjects for the problem they have to solve is included in the experimental design. Half of the subjects have this opportunity and are randomly selected by the server application that orchestrates the experimentation over the Internet. The DSS presents simulated situations that resemble the problems that will have to be solved later during the experiment. Subjects can place the new outlet in different location and see the market share they obtain. They can compare these solutions to the optimal solution that can be computed by the system.

Figure 5. - A Decision Support System solving scenario and simulated problems



(a) Java applet used as a location DSS

b) Web page form using Liveconnect technology to send scenarios to the applet.

The DSS and its integrated simulated problems generator can give the decision maker a better feeling of the problem to solve. It implicitly reveals important aspects and variables to be taken into account in order find better solution.

The hypothesis we make is that solving similar problems in advance with a DSS improves later unassisted decisions (H4a) and reduces the duration of those decisions (H4b).

Experimental design

The variables and their various levels that are combined in an experimental design in order to obtain different map situations are shown in table 1.

Table 1. Variable and variable levels used to build an experimental design*

Problem size	Dispersion	Aggregation	Own network	SAD
1. small (18 sites) [s]	1. low [l]	1. 50 zones	1. absent [n]	1. absent
2. big (47 sites) [b]	2. medium [m]	2. 100 zones	2. present [c]	2. present
	3. high [h]	3. 200 zones		

* Entre [] se trouvent les notations mnémoniques qu'on utilise pour appeler les situations générées.

Except the DSS whose availability is randomly administered, the remaining four variables with their levels are combined in a complete experimental design. There from 36 images have been created that represent all situations of the experimental design (2x3x3x2).

Optimal solutions for all situations are shown in table 2.

Tableau 2. Optimal solutions to 36 location problems resulting from a complete experimental design

Design	Mnemonic*	Market share	X	Y
1111	sl200n	0,12231777	372	231
1112	sl200c	0,62768203	236	312
1121	sl100n	0,11950278	362	222
		.....		
2331	bh50n	0,28695092	268	296
2332	bh50c	0,5384263	269	295

* The mnemonic column uses notations introduces in the preceding table in order to label each situation. For example sl200c signifies: small problem, low dispersion, aggregation level 200 zones and own network available.

During the experiment each subject must solve three problems indicated in a row that is selected randomly form a scenario with 36 rows. The composition of the scenario is shown in table 3.

Tableau 3. Scenario composition with three problems per subject

Scénario	Problème 1	Problème 2	Problème 3
1	sl50n	bm100n	sh200n
2	bl50n	sm100n	bh200n
3	sl100n	bm200n	sh50n
4	bl100n	sm200n	bh50n
5	sl200n	bm50n	sh100n
6	bl200n	sm50n	bh100n
7	sl50c	bm100c	sh200c
8	bl50c	sm100c	bh200c
9	sl100c	bm200c	sh50c
10	bl100c	sm200c	bh50c
11	sl200c	bm50c	sh100c
12	bl200c	sm50c	bh100c
....			
36			

Note: rows 13 to 36 use the same problem sets as in rows 1-12 only the order of problems is changed.

The dispersion of information is the within-subject controlled variable. The presence of the DSS and of the second distribution network are variables controlled between subjects. The other two variables the size of the problem and data aggregation record variation between and within subjects according to a balanced experimental design.

Experimental Task

The experimental task the subjects have to fulfil is shown in figure 6. Each subject participates in three experiments that present different situations on the map. During each experiment the subject is invited to move the new site represented by a flashing square at the location they consider best, taking into account the given map situation. The coordinates on the vertical and horizontal axis of the location that was indicated by the subject are recorded by pushing a button in the text input zone that corresponds to the current experiment. Each recording launches the next experiment and displays a new image with another map situation.

Figure 6. - Experimental task execution

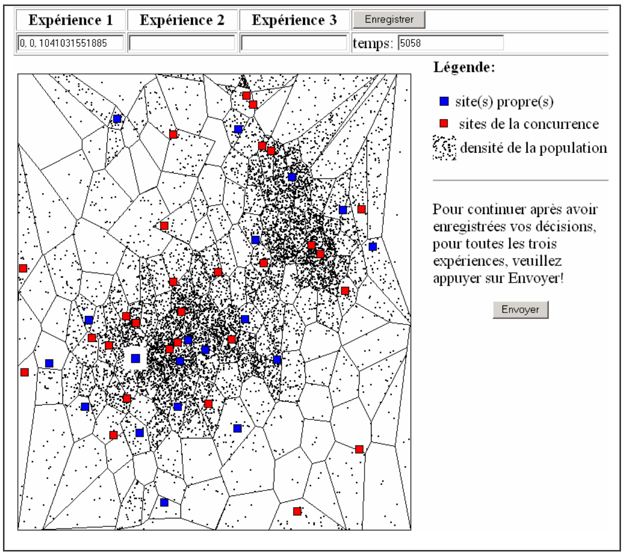


Figure 6 displays a situation where the subject has a big problem to solve with 47 sites, divided into two distribution networks, with low aggregation (200 zones) and medium dispersion.

Results

Comparative results between the original study and this extended Internet replication are given in tables 4 and 5.The quality of each subject's best solution was obtained in the original study by computing the percentage deviation of the user-generated solution's operating cost from the optimal solution's operating cost. In our study we simply used the distance between the subject's best location (solution) and the optimal location. The average values of these deviations from the optimal solution are shown in table 4.

Table 4 – Average and standard deviations of experimental tasks for each variable level in the original study and in its replication over on the Internet.

	Original study			Replication		
	N	Average	Std. error	N	Average	Std. error
Dispersion						
low	162	4,45	6,42	53	27,258	3,207
medium	161	4,42	6,2	53	29,355	3,433
high	157	2,62	5,21	53	38,102	2,832
Size of the problem						
small	240	3,12	5,55	94	24,016	2,235
big	240	4,57	6,39	65	39,582	3,053
Aggregation						
50	119	3,08	4,4	52	37,223	3,388
100	121	3,6	5,72	58	32,872	3,006
200	119	3,79	6,21	49	24,970	3,241

400	121	4,89	7,71	0	-	-
Own network						
present				72	34,194	2,751
absent				87	27,469	2,329

The effect of the size of the problem on decision quality has been statistically significant in both studies and confirm hypothesis H1a. The effect of information aggregation has been statistically significant with p=0,01 and confirms hypothesis H2a, the original study wasn't successful neither in verifying this effect nor for the variation direction neither for the significance. The dispersion effect has been less significant statistically than the original study (p=0,05) and doesn't confirm the variation direction from hypothesis H3a. It is probably the graphical solution that we adopted to represent dispersion of demand that hasn't been well chosen and probably lead to misinterpretations. The interaction effects on the average more significant in the original study and more thoroughly analysed and discussed there because of weakness in main effects, haven't been significant in this replication and don't need a special discussion. They are however given in table 5 in order to allow comparative analysis.

Tableau 5. - Summary of main and interaction effects

Main effect	Reference	Replication
Dispersion	< ,001	0,05
Problem size	< ,001	< .001
Aggregation	,424	0,011
Dispersion*Size	0,234	0,221
Dispersion*Aggregation	0,098	0,687
Size*Aggregation	0,112	0,165
OwnNetwork*Dispersion		0,579
OwnNetw.*Aggregation		0,151
OwnNetwork*Size		0,612

Unfortunately the use of the DSS during this first experimentation wasn't tracked correctly and the system changed interface several times during the experiment so that its impact on decision quality could not be measured. In any case its implementation and integration into the experimental process reveal many useful possibilities web application offer for such experimentations. In contrast with the original study we didn't impose time pressure over the subjects and therefore ignored decision time effects.

The results obtained up to this date are encouraging. They confirm most of the tested hypothesis from the original study and indicate the need to continue this study in the future.

Experiment 2: Impact of market information and DSS use on the performance of participants in a strategic marketing simulation game

over the Internet

The impact of a DSS on decision making performance has been introduced in the first experiment as an additional variable that didn't exist in the original study. The problem to solve, the location of retail units is equivalent to positioning products or brands which is a more general problem in marketing. This kind of problem is central to the marketing simulation that we have built on the Internet. In this simulation (a strategic marketing game) subjects can take brand positioning decisions, manage a marketing budget and compete with other real or virtual managers during several simulation periods in environments where the availability of DSS is controlled. In this way DSS aspects aren't marginally but fully dealt with. This time we try to replicate a laboratory experiment done by Van Bruggen, Smidts and Wierenga (1996, 1998) using the Markstrat (Larréché and Gatignon, 1990) simulation environment. The objective is on one hand to contribute to increase external validity of the evoked study and on the other hand to test the ability of web applications to substitute laboratory environments in such experiments.

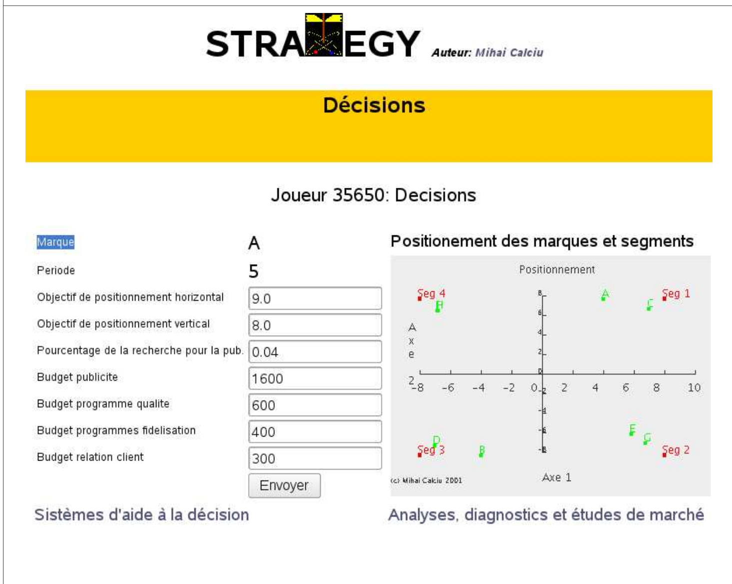
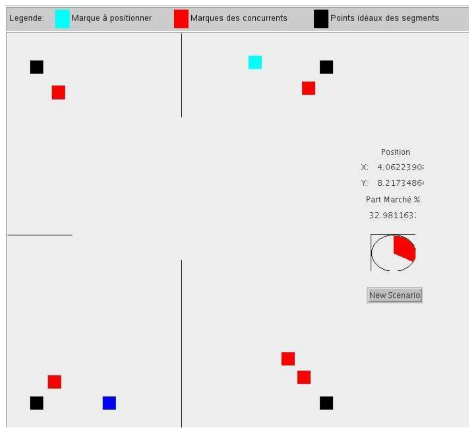
Presentation of the simulation

The simulation is organised as a business game that although minimalist manages to cover all important aspects of marketing. On aspects regarding brand positioning policies it resembles Markstrat and as such favours replication. The marketing logic is more schematic in order to keep the problems to solve self describing and to avoid asking subjects to use documentation in order to prepare for the task. Such a step is difficult to impose over the Internet where subjects are not captive as in laboratory and we have to rely on Internet surfer's goodwill. Market shares are given by a simplified response function that is directly applied to brand attractiveness and distance to segment ideal points without passing through intermediary stages (buying habits, referencing by retailers, buying intentions etc.). In contrast this simulation adds the relationship dimension of marketing. It introduces customer loyalty towards brands and key and non-key customer sub-segments which makes estimating market shares as complex as in Markstrat.

Experimental task

The simulation creates an environment in which four firms compete. They use a set of marketing instruments in a market with heterogeneous consumer preferences. Each subject plays the role of a decision maker on behalf of the firm selling the brands called A and B. The other three firms acting in the same market are “virtual” companies. Their decisions are pre-programmed. Each decision maker's objective is to maximise the company's gains. In order to reach these objectives he must divide his budget between transactional and relationship marketing mix elements. The transactional mix consists mainly of positioning and repositioning brands using advertising budget in order to attract a maximum number of customers. The relationship mix budgets are used to enforce customer loyalty towards a brand (Fig. 7a.). The subjects don't know in advance the number of periods they have to play. In this way the “end of game” effect is avoided (see Van Bruggen, Smidts and Wierenga, 1998). The subjects are not competing against each other. They are all confronted with the same start situation and to the same game scenario. This keeps subjects' decisions comparable. This approach is defended by Lucas and Nielsen (1980) and applied in the study of Van Bruggen, Smidts and Wierenga (1998) that is replicated here.

Figure 7. – The Marketing simulation's decision making page and integrated decision support

(a) Decision making	(b) Decision Support System
	

Decision support

Half of the subjects can access a DSS (Fig. 7b) to test several positional market situations and perform «what-if» sensitivity analyses in order to study the market share obtained by a given positioning. To do these calculations the DSS uses the same location/positioning model that was used in the first experiment and presented at the beginning of this article. The system can generate simulated situations where the brand and ideal segment position vary randomly still keeping the number of own and competitor's brands, the number of segments and the limits of variation from the original scenario. Other information available to decision makers consists of data on demand, financial results of the firm, customer flows, brand positioning, brand attraction and loyalty index etc. (see figure 8). They can be viewed during each simulation period.

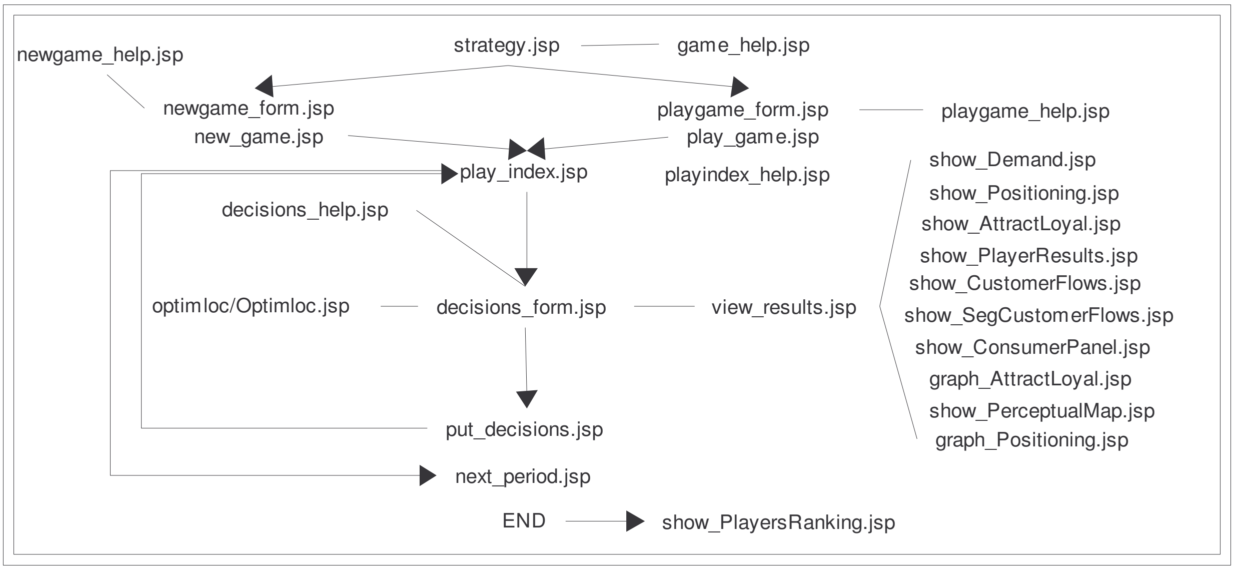
Performance Measures

As a measure of decision making performance we used the marketing contribution (profit) that was obtained after five simulation periods. This is close to the off-line study that used the same measure obtained after only four periods. Independent variables are alternatively the availability and the use of the DSS as well as the use of market information. Other variables like decision maker's cognitive style or time pressure could be introduced later in the development of this on-line experimentation in order to bring it closer to the off-line study it tries to replicate.

Results

The experiment lasted 20 days. There were 8037 pages visited by 110 participants (French students in marketing and young Romanian employees) out of which only 49 have played the game up to the end of the five periods, the others dropped out before. Three additional subjects had to be eliminated due to subject multiple submission fraud, meaning the same person participated in more than one simulation using different identifiers. Among the 46 finalists, 25 had DSS access and 21 didn't. We also realised that only 14 of the 25 finalist decision makers who had access to the DSS also used it. The other 11 didn't take this opportunity. In order to help understand the behaviour adopted by the 46 subjects that have completed the game, figure 8 shows the dynamic server pages that formed the navigation process during the simulation. The arrows indicate compulsory navigation links while the lines show optional links. Apart the links to help pages there were two optional links from the main decision page, one towards decision support and the other towards market information.

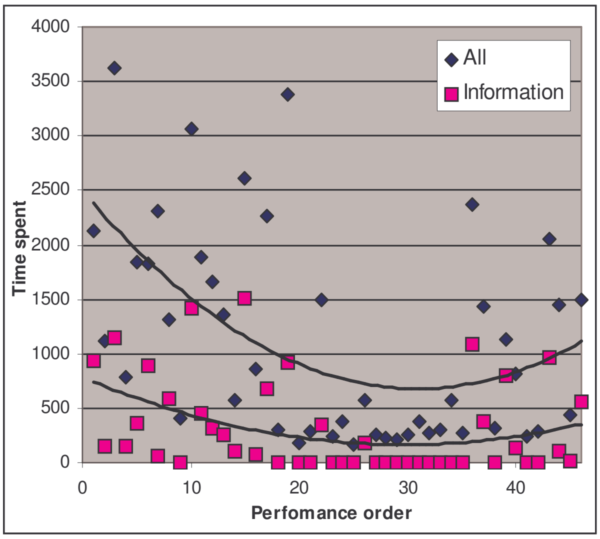
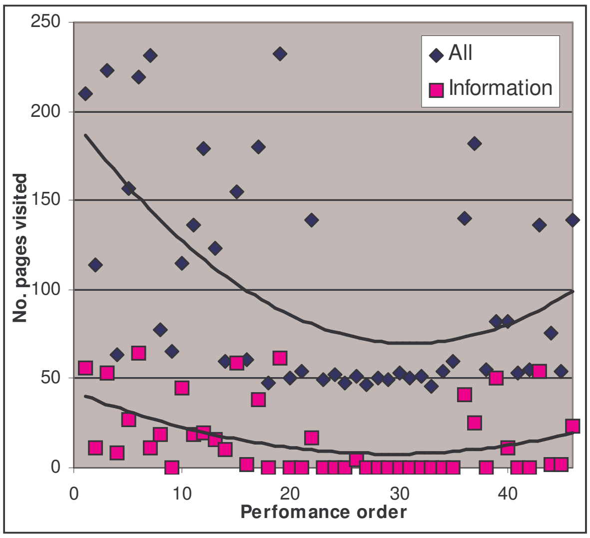
Figure 8 – Web marketing simulation navigation scheme



We recorded the time and frequency of use for each subject's complete navigation process as well as for the part dedicated to decision support and to market information in order to measure their influence on decision maker's performance.

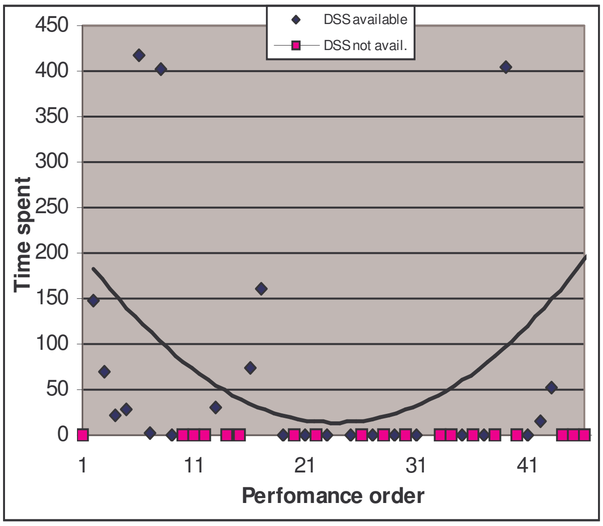
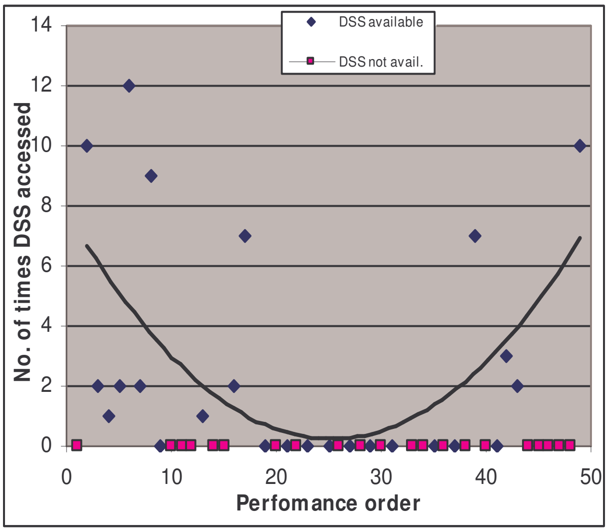
A first hypothesis we tried to verify was that *people who spend more time and visit more pages in* *general were more successful*. The rationale behind this hypothesis is that such people are more implicated and gather better knowledge about the environment in which they act and are therefore able to take better decisions. Figure 9 shows that the wining third (17 subjects) spent a lot of time with the simulation and with consulting market information, the middle third (17 subjects) was rather quick and most of them didn't use any market information, while half (6 subjects) of the losers (11 subjects) spent some time and gathered some market information. This last aspect is rather paradoxical but can probably be explained by the fact that in all groups of people there are some laggards who are rather slow and lack intuition.

Figure 9 Perfomance vs. Time spent and number of pages visited for the whole simulation and for market information

(a) Time spent	(b) No. pages visited
	

The second group of hypothesis we were making was that the time and frequency of DSS use had a positive impact on decision makers' performance. Figure 10 shows that except the winner who didn't have access to the MDSS, most members (11 subjects) of the top third (17 subjects) are frequent MDSS users, the middle half is formed of participants who either didn't have the opportunity to use or simply didn't use the MDSS and among the worst performers there are also four MDSS users who probably being laggards didn't get the point in due time.

Figure 10 Perfomance vs. Time and Frequency of MDSS use

(a) Time of use	(b) Frequency of use
	

The data collected up to this point are certainly not enough to apply thorough statistical tests in order to confirm our hypothesis, but the graphical analysis of results is rather encouraging in this respect and helps bring some external validity to the off-line study it tries to replicate. Another objective of this paper is to present the possibilities offered by the Internet and especially by the web to build such experimentations using on-line simulations and show their role in measuring the impact of DSS on managerial performance.

The role of such experiments isn't limited only to measure DSS impact. Experimentation with marketing simulations can ease measurement difficulties that have been encountered for long time in marketing strategy and planning research and constitutes a powerful alternative to survey based primary data collection methodologies (Malhotra, Peterson and Kleiser 1999). As the network-centric approach to business fostered by Internet generates complex interactions between players that alternate competition with collaboration, there is an increasing need for the development of simulation models to help managers evaluate strategic options (Lilien and Rangaswamy, 2000).

By manipulating environments with varying turbulence growth levels, one can reveal different information treatment behaviour (Glazer and Weiss, 1993). By using the transactional/relationship duality of the model this simulation relies upon we could for example, develop scenarios with varying market growth rates and explore eventual variations in the importance given by subjects to offensive versus defensive marketing strategies and to other transactional and relationship marketing aspects.

Discussions

This research deals with a category of Internet experiments studying the marketing decision making process. It explores the advantages offered by the new media for experimentation and presents two implementations that use up-to-date web application technologies to cover diverse experimentation modes and implementation logic.

The first experiment studies *effects of problem complexity, visual presentation and availability of a decision support system on decision performance*. Decision performance is measured in terms of decision quality and decision preparation time. The analysed problem is how to locate a new retail outlet depending on spatial distribution of demand and competitors' locations.

The developed experimental design varies the problem complexity, geographic information presentation and location DSS availability. The problem complexity is manipulated on two dimensions : number of retail outlets to take into account and presence or absence of the actor's own retail network. Geographic information presentation must deal with complexities inherent to such data rich problems and can have ambiguous impact on the quality of location decisions. Here we manipulate essentially the presentation of demand data, by varying territorial aggregation levels and data dispersion. Access to a DSS for a part of the subjects before decision making that has been programmed in the experimental design can reveal the impact of decision support on decision making performance.

The questions approached by the two experimentations cover several aspects of the decision making process: information treatment, choice and decision support. They distinguish themselves by the diversity of mobilised Internet technologies. They progressively introduce functionalities integrated on the client program (the browser): JavaScript, dynamic HTML, applets then server functionalities: CGI and programmes written in the Perl language, Java Servlets, dynamic server pages (PHP, JSP), database server and «multi-tier» application building technology that separates presentation logic (Servlets, JSP) from application logic (Java Beans) and data access.

The results of the replications made over the Internet resemble a lot the ones of the original off-line experiments and are in most cases statistically significant despite the somehow demonstrative, preliminary character of these experiments, reflected by the relatively reduced number of participants

This conducts us to recommend using the Internet for laboratory experiments replications more frequently (if not systematically) wherever this is feasible. In this way we can increase external validity of experiments at a minimum cost and eliminate temporal and spatial barriers that off-line replications encounter.

In contrast and excepting experiments studying virtual electronic environments (Dreze and Zufrieden, 1997; Galan and Sabadie, 2001; Gonzales, 2001; Cases A-S, 2002), implementing original experiments over the Internet risks to be reductive due to limits of electronic environments in general and of the Internet in particular. Today's limitations linked essentially to communication debits still make it difficult to insure satisfying degree of realism despite powerful multimedia and virtual reality applications.

Also due to the absence of “captive” subjects, the duration and complexity of the on-line experiments must be limited in order to keep a certain attractiveness to avoid dropouts and not disturb what remains of the traditional goodwill of Internet respondents after the rapid “urbanisation” of what had been called before the "world wide village".

Each of the on-line experiments presented here merits individual development that will be continued. They will evolve as perpetual on-line experiments that will progressively integrate advances in web application technologies and produce additional results. They are well suited and remain open for inter-cultural studies concerning managerial performance on a European or larger international scale.

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