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Mobile technologies diffusion in tourism: modelling a critical mass of adopters in Italy.

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Abstract

The next generation mobile technologies have very important implications in the travel and tourism sector. Tourism presents great potential for the use of new mobile technologies and constitutes an area of ample opportunity for deploying the state-of-the-art mobile Internet technologies. A survey has been conducted on a random sample of Italian university students, one of the most important segments of cellular telephone users, in order to analyse the main determinants for the building of a critical mass of adopters of 3G mobile technologies. This critical mass is fundamental in guaranteeing a “mass” diffusion. Students’ networks exhibit non-random structures, therefore the speed with which an opinion or a piece of information spreads is very high. A possible growth pattern is modelled. The largely positive attitude toward the adoption of 3G technology shown, allows the modelling of a short term build-up of a critical mass of users.

Keywords: Mobile technologies, mobile Internet services, technology adoption, tourism mobile services, 3G.

1 Introduction

The implications of the next generation mobile and wireless technologies in the travel and tourism sector are very important. Tourism presents great potential for the use of new mobile technologies and constitutes an ample opportunity area for deploying the state-of-the-art mobile Internet technologies. It is becoming increasingly necessary to provide travellers with real time information to assist them in planning their activities while travelling. Travellers - whether leisure or business - want fast, flexible and convenient information services on top of the attractions that a destination offers.
In other words, what travellers in general, and tourists in particular, expect are services:

- customized (or customizable) to their individual needs and preferences;

- timely and accurate in their contents and available while being on the move.

Many believe the so-called 3G (third generation, essentially based on UMTS standards) technology is the wave of the future. It brings the Internet to mobile phones and allows users to send or receive large amounts of information, such as video, through their mobile devices. Nonetheless experience so far has shown different degrees of acceptance and adoption by the users. Wap is still much underutilized while the NTT DoCoMo *i-mode* has attained a huge success in Japan and is presently being exported to different countries.

The key question for success is the capability to provide attractive contents at reasonable prices. An increase in customer numbers is strongly related to these elements and may well lead to new customers generating a value added virtuous cycle. These ideas are supported by a variety of predictions, most of them base on the sales figures of mobile phone devices (Durlacher, 1999, 2001).

Italy is one of the largest markets in the world for telecommunication services and one of the favourite tourist destinations among international tourists, so it is no wonder that the market for mobile communication is considered valuable and promising by all types of market players.

The aim of this paper is to analyse the main determinants able to ensure the building of a critical mass of travellers/tourists for the adoption of 3G mobile technologies. This critical mass is fundamental to guarantee a "mass" diffusion. Moreover, a possible growth pattern of the diffusion of tourism related 3G mobile technologies is modelled.

2 Mobile technologies usage in Italy

According to ITU (2002) statistics, Italy is the second European country as for number of subscribers (more than 52 millions) and number of devices per 100 inhabitants (92.7). Accounting for multiple subscriptions the total estimate is of about 37 million users (ISIMM, 2003; ISTAT, 2002). The age distribution and penetration of the usage of mobile phones are shown in Table 1.

Table 1. Age penetration of Italian mobile phones

Age group	Distribution	Penetration
14-24	18.3%	94.4%
25-34	22.3%	90.7%
35-44	19.2%	81.0%
45-54	14.2%	68.0%
55-64	13.2%	58.8%
> 65	12.8%	45.0%

In a cluster analysis of Italian cellular phone users, ISIMM (2003) identifies a consistent group (16.3%) of technologically advanced people. They are young people (aged 25 to 35), with medium-high education (college and higher degrees) and a good propensity toward innovative uses of the mobile phone.

3 Innovation diffusion in a social network

The cost of the UMTS licenses paid by telecom operators in Western Europe is a high investment. The total amount is of about € 120 million (almost € 320 per subscriber). More than that, the operators are expected to invest, in the next three years, a comparable amount of money to implement fully the infrastructure needed for the operations. The size of these investments is the main reason for the delay in the full deployment of the UMTS services. On the other end, once what set of contents and services is the most appealing for the average customer is recognised, it is important to figure out a possible rate of diffusion of the new technology. Contents and services particularly suited for the 3G mobile users have long been identified with location-based services, multimedia messaging, mobile internet access, retrieval of time sensitive information (tickets, weather, schedules, etc.) and customized infotainment (see for example: UMTS, 2001). Most of these can be of great usefulness for a “mobile traveller”. Nowadays mobility can be thought of as the strongest factor influencing consumers’ preferences. Mobility is also, with no doubt, the most compelling force behind the success of cellular communications. Mobility is, finally, a “genetic” characteristic of a tourist.

It has been well established that the spread of a successful innovation over time follows an S-shaped curve (Rogers, 1995). Initially, only a few members of the social system adopt the innovation. Afterwards, as the diffusion process develops, an increasing number of new adopters is detected. This is the phase of rapid market growth. Finally, the diffusion curve slows down and eventually reaches an upper saturation level. In the diffusion of any innovative technology, a “critical mass” of adopters is thought to be crucial to sustain the process until the expansion phase is well established (Valente, 1995; Markus, 1987). To reach critical mass a substantial number of individuals must commit to using the technology with little certainty of obtaining a benefit for themselves (Oliver et al., 1985). Valente (1995) notes that the critical mass is achieved when about 10 to 20 percent of the potential market has adopted the innovation. In the diffusion process, the interaction among the members of the social system is one of the most important drivers. The extent and the frequency of these interactions are the engine that control speed and possibility of an universal dissemination.

Models like the Bass model (Bass, 1969) propose that the adoption of a new technology is determined by external factors (e.g., government policies, mass media communications, competition, standards) and intrinsic factors (type of innovation, technology characteristics, etc.). Its further extensions take into account the influence of market variables and the evolution of different generations of the same basic technology (Bayus, 1987; Norton and Bass, 1987, 1992). The essence of the model, however, implies that a new product adopter can spread his enthusiasm to anyone else in the market. Moreover, in their diffusion, many technologies, and mainly the communication technologies, are influenced by network externalities, where the utility derived from the system increases as the number of users increases (Katz and Shapiro, 1994).

A social system can be seen as a network in which the nodes are the members and the links are the relationships established among them. Network analysis techniques are very important for innovation diffusion analyses because they help to determine reciprocal influences (Conway et al., 2001). This approach leads to refine the model and to reconsider the critical mass concept. Literature shows that the critical mass varies with the distribution of the population and with the social network structure (Valente, 1995).

The topology of the network is important for the understanding of the flow of information and therefore of one of the main determinants for the diffusion of an innovative technology or product.

The use of random networks to model the web of connections in complex systems has been introduced with the seminal work by Erdös and Rényi (1959). The basic assumption underlying this model is that the connections are established in an entirely random way: the network is composed of N nodes and there is a fixed probability p that any two nodes are connected by a link.

The number k of connections per node (*node degree*) is distributed according to a Poisson probability distribution, $p(k)$. The random graph model predicts that the average path length L (the average number of links in the shortest chain connecting two nodes in the network) is small (it scales with $\log N$) as well as the *clustering coefficient* C (the average fraction of pairs of neighbours of a node that are also neighbours of each other).

In recent years, however, it has become evident that many real networks exhibit short average path length, small diameter (maximum distance between any two nodes), but high ($0.5<C<1$) clustering coefficient (Albert and Barabási, 2002). Examples include social networks, the World Wide Web, cellular metabolic networks, power grids.

Two theoretical models (each one with several variants) have been proposed to account for these properties:

- the Watts-Strogatz (WS) model (Watts and Strogatz, 1998), where the presence of short paths is mainly due to the introduction of shortcuts between distant nodes. These are called *small-world* (SW) networks for this characteristic;

- the Barabási -Albert (BA) model (Barabási and Albert, 1999), where the nodal degree distribution follows a power law with few highly interconnected nodes (*hubs*) and a short *L*. These are called *scale-free* (SF) networks for the absence of a "characteristic" path length (the average L of the Poisson distribution of a random network). SF properties evolve in large complex networks through self-organizing processes. More specifically, a "preferential attachment" rules the growth. New nodes tend to connect themselves to others that are already well-connected (with high node degree).

The major attribute which distinguishes the two models is the degree distribution $p(k)$ which allows one to detect, for every real-world network, which model (or combination of models) provides a better approximation.

One of the most striking features of such networks (SM and SF) is the speed with which an "infection" spreads. It can be an opinion, a rumour, an information, a virus in a computer network or a disease in a population.

There has been much interest in the spread of epidemics in non-random networks. It has been shown (Pastor-Satorras and Vespignani, 2001) that scale-free networks are more susceptible to "infections" than networks with a more even degree distribution. In a random network, the spreading needs to exceed a threshold of infectiousness in order to propagate. In SF networks, the threshold for the propagation rate above which an infection of the system spreads and becomes persistent is very much lower than in other disordered networks, or even vanishes. Callaway et al. (2000) have shown that the threshold for epidemic propagation (the percolation threshold), is zero in random scale-free network with a power law exponent $a \leq 3$.

In other words: rumours (or information) spread extremely fast in the presence of short path lengths and high clustering coefficients (Zanette, 2002).

4 3G adoption empirical survey: methodology

A survey has been conducted on a random sample of 350 Italian university students. Although not representative of a whole population, this segment (people aged 18 to 25, high education, medium to high incomes) is the largest portion of mobile telephone users (see Table 1) and may well be considered the highest contributor to a critical mass of adopters. Several market surveys have in fact shown that the age of a respondent is one of the single most relevant demographic variables that impacts on maximum potential demand and demand for mobile services is significantly higher in younger age groups.

Data were gathered by means of a questionnaire (direct interviews) in March/April, 2002. All of the people surveyed possess a "second generation" cellular phone (GSM, WAP and GPRS). The questions in the survey concerned the intention to move to a 3G cellular phone, a set of possible tourist information services (Table 2) and the willingness to pay for such services.

Table 2. Services surveyed

Service	**Description**
city centres	general information on historical city centres
discos	general information on discos, pubs and more meeting places
hotels	general hotel information and availability/booking
localization	localization services, maps and driving directions
monuments	general information on monuments and historical buildings
museums	general information on museums and exhibitions
restaurants	general restaurant information and availability/booking
tickets	ticketing services for travel and/or shows
travel sched.	travel schedules
weather	weather information, sea and snow conditions, etc.

A number of studies (Albert and Barabási, 2002; Ebel et al., 2002; Adamic and Adar, 2003) have demonstrated the non-random properties of the network of relationships in communities of high school, college and university students.

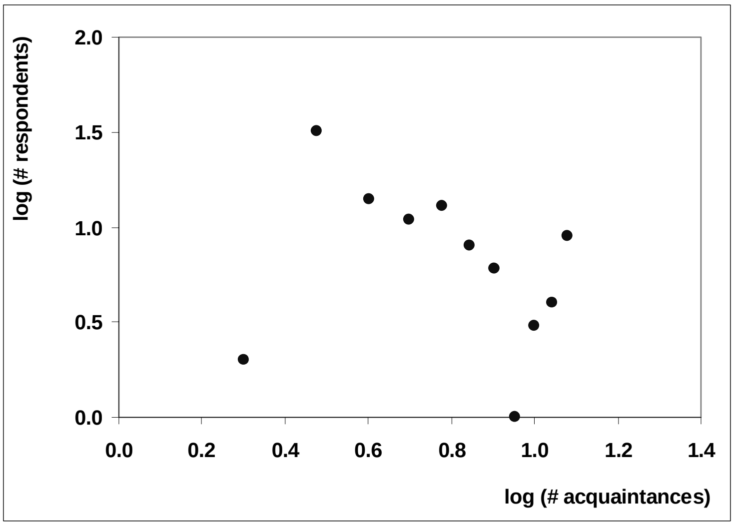

Fig. 1. Distribution of the relationships in respondents' network

As an attempt to check the network characteristics, the respondents were also asked to indicate the number of acquaintances with which they would have discussed the

adoption of a 3G cellular phone.
The sample surveyed is too small to be able to draw significant conclusions. In any case, these answers (the degree distribution is shown in Fig. 1) provide a rough confirmation of a non-random structure. A computer simulation of a network with the same degree distribution leads to the following results: diameter D = 5, average path length L = 2.8, clustering coefficient C = 0.62. A random network with similar D and L would have a C ≤ 0.01. The hypothesis of a small-world structure can be reasonably confirmed.

5 3G adoption empirical survey: results

Moving to the next cellular generation looks appealing for most of the people surveyed. In fact 71.1% of them have considered likely or very likely the technology substitution in the near future (≤ one year from a general availability). The full results are shown in Table 3.

Table 3. Attitude towards the adoption of 3G cellular technology

Not likely	Likely	Very likely
28.9%	51.4%	19.7%

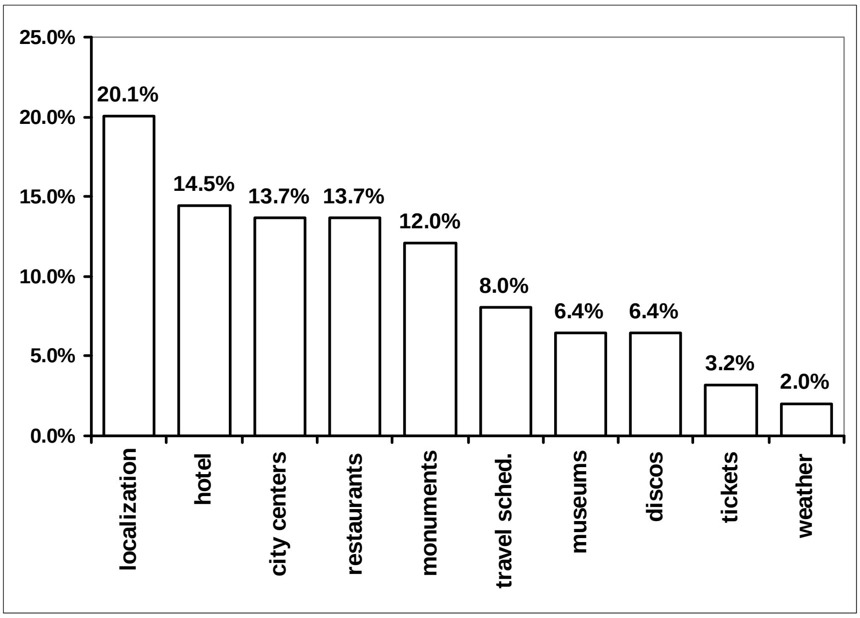

Fig. 2. Survey results

The features required have been assessed by asking the people surveyed to choose the single most important service that would have justified the acquisition of a new generation device from the list in Table 2. The results of the survey are depicted in Fig. 2.

A great number of respondents, however, (68% of the probable adopters) have posed as a condition the availability of specific services, most of them tourism-related. The simple offering of "multimedia" capability is not considered a necessary and sufficient condition for the adoption. From an economic point of view, the respondents have expressed a general willingness to pay a reasonable amount of money for accessing these services. The payment intentions are shown in Table 4.

Table 4. Willingness to pay for 3G services

Willing to pay	**62%**
Flat rate	14%
Pay-per-use	48%
Not willing to pay	**38%**

Respondents willing to pay generally prefer a pay-per-use (48%) method to a fixed price (14%) subscription. On the average the price increase considered "reasonable" is 20%-25% higher than the present tariffs.

People intending to adopt 3G technology, but not willing to pay for the services have stated they would accept advertising messages as a form of compensation.

In conclusion, a great majority of students have expressed their intention to switch to a 3G cellular technology, provided they can "justify" the adoption with the availability of interactive services, mainly related to tourism activities. They also have a good attitude toward the payment (in different forms) of the services provided.

6 A forecast of the 3G technology diffusion

The result of the survey can be interpreted as a good opportunity to build up, in a reasonable time frame, a critical mass of users that can favour the general diffusion of these technologies. Due to the topological structure of the network of relations in the student group, the spread of the acceptance can be thought of as guaranteed once the first elements start using the new devices.

With the data collected it is possible to attempt a forecast of the diffusion of the new technologies, at least for the services analyzed.

To do so, the Bass model can be used. The model equation (Bass, 1969) is given by:

$$n(t) = pM + (q - p)N(t) - (q / M)N(t)^2 \quad (1)$$

Where *n(t)* is the number of subscribers at time *t*, *N(t)* is the cumulative number of subscribers at time t and M is the potential size of the market. The key parameters for the model are the initial trial probability p (parameter of innovation) and the diffusion rate parameter q (parameter of imitation). Parameter p captures the influence that is independent from the number of adopters (external communication, technology characteristics) and indicates how quickly the innovation is initially adopted by the population while q reflects the influence of those consumers who have already adopted the product (internal relationships in the social network). For an “order of magnitude” forecast the extensions to the basic model may be ignored.

The literature on the Bass model estimates the model parameters p and q directly on a backward-looking basis from sales or saturation data (Baggio and Caporarello, 2003). In the case under investigation these data are, obviously, not available. The only possibility is to work by analogy, using values derived by the modelling of similar technologies (as suggested for example by Turrettini and Young 2001). Besides the older generation cellular telephones and cordless telephones, internet connections and email are considered because of the affinity with the digital services that 3G mobile technology may offer. Using the published values (Bayus, 1987; Sultan et al. 1990; Turrettini and Young 2001; Lilien and Rangaswamy, 2003) and a regression on the Internet users historical data, the average values obtained are: $p = 0.0095$ and $q = 0.725$. The p and q values may be increased:

- *P value*: as users will already be familiar with the basic usage patterns of mobile phones and because of the high advertising pressure;
- *Q value*: to take into account the topology of the network of users that favours a fast “infection”.

We may thus obtain a range of values (Min = average values, Likeliest = 1.25·Min, Max = 2·Likeliest) used to model the diffusion (Table 5).

Table 5. Model parameters

Parameters	Min	Likeliest	Max
p	0.0095	0.012	0.025
q	0.725	1.1	1.3

The results of the survey (71.1% of probable adopters) can be used to estimate a market size for tourism related services. With an estimate of a 30% share (UMTS Forum market statistics, online at http://www.umtsworld.com [September 2003]) and an Italian mobile user population of about 40 million (almost saturated, see ISIMM, 2003 and ISTAT, 2002), it is reasonable to set a size in the range 8 to 10 million users. The cumulative distributions obtained are shown in Fig. 3.

Assuming a 20% size for the critical mass, this value can be reached in the time frames specified in Table 6.

Table 6. Critical mass timeframes

	Min	Likeliest	Max
Years to reach "critical mass"	1.5	2.4	3.6

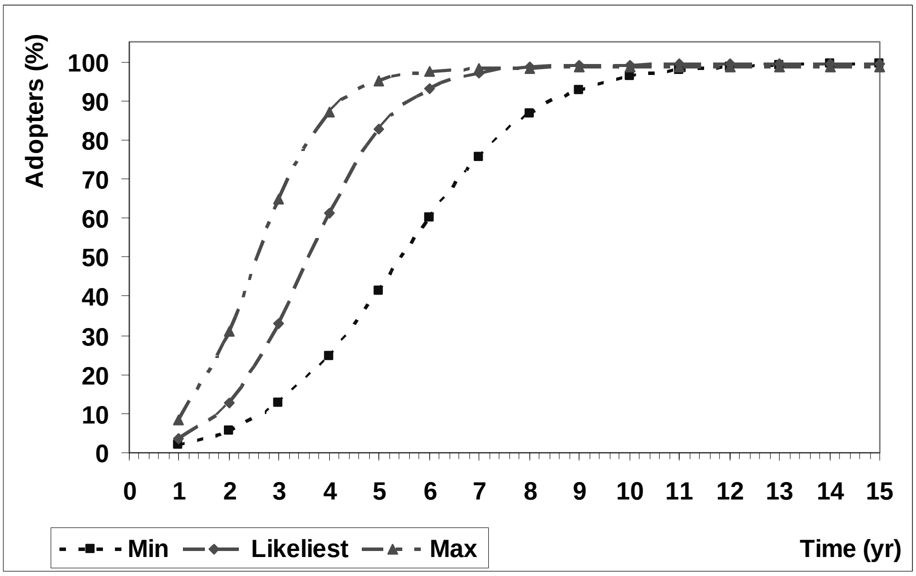

Fig. 3. Model cumulative distributions

It must be noted that these values are highly uncertain due to the nature of hypotheses assumed (similarity with older technologies and adoption pattern), nonetheless they can be reasonably give . The annual report of the Italian Telecommunication Authority (downloadable on: http://www.agcom.it [August, 2003]) estimates a cautious size of 6.3 million UMTS users in 2005, which is consistent with our results.

7 Conclusions

The timescale over which a significant migration from second to third generation mobile technologies will be achieved will depend upon the dynamics of the market. Several conditions must first be met before mass take-up of 3G services will occur. They regard mainly prices and availability of services, devices and network infrastructures.

A survey on a sample of Italian university students, one of the most important segments of cellular telephone users, has shown a largely positive attitude (71.1%)

toward the adoption of 3G technology. The main determinant has proven to be the availability of tourism related applications. The majority has also expressed a general willingness to pay for these services, recognizing a 20%-25% "added value" to the new generation capabilities.
This result is important in consideration of the structure of the relationship network in this user group. In fact, the non-random topology favours a fast spread of the new products adoption thus speeding up the formation of a critical mass essential to sustain a general diffusion. This critical mass, modelled by analogy with historical diffusion data of similar technologies, can be achieved, in the likeliest case, in a 2.4 years timeframe after the operational introduction of 3G cellular networks.

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