

A SYSTEM DYNAMICS APPROACH TO MODELLING A NATIONWIDE MOBILE COMMUNICATION MARKET

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Abstract: The mobile telecommunication industry is becoming one of the most important industries in the world. In the spectrum of wireless communication technologies, digital cellular telecommunication using the Global System of Mobile Communication (GSM) standard has enjoyed the fastest growth rate. This paper attempts to examine GSM driving factors on a national level. For this purposes, it uses system dynamics as a well-proven approach to capture the complexity of GSM demand. The paper illustrates the modeling approach for the Germna market.

Keywords: Telecommunications, Global System of Mobile Communication (GSM), System Dynamics

1. INTRODUCTION

In 1982, the Global System of Mobile communication (GSM) was established to initiate European telecommunication standards. Since 1992, it has been swiftly adopted by nations around the globe. Its growth is even faster than the already explosive telecommunication market which reached US\$535 billion in 1992 (ITU, 1994). GSM is already the largest segment within mobile communications and should further increase its share until the year 2005, as it becomes the most important telecommunication sector (Eutelis, 1993).

As a new technology that provides obvious and immediate benefits for all users, regardless of the characteristics of the country of their residence, one can safely argue, at least for the short term, that GSM demand will continue to grow. In the long run, however, the pattern and growth must certainly change as the forces that drive it change. Will GSM demand continue to grow indefinitely? What are the economic, social and technological factors that drive GSM national demands? How do these factors behave across countries with different economic, social and geographic profiles? Answers to these questions would help researchers in the

telecommunications field, government or regulatory policy makers, handset manufacturers, network operators, and service providers better understand the long term demand trends.

A first step toward a better understanding of its international impacts is to observe its demand characteristics for various nations. We propose the approach to choose three countries of distinct social, economic, and cultural profiles: Germany, Hong Kong and Vietnam. Each of the three is representative of a number of other countries.

2. A SIMULATION MODEL FOR GSM NATIONAL DEMAND

2.1 The Driving Factors of GSM National Demand

Based on previous research, we have identified seven factors that are known to influence the GSM demand (Altobelli, 1991; Loebbecke, 1995; Veldkamp 1996). These are described below with the names of the variables used in the demand model given in parentheses for presentation and discussion purposes. *Cost*: Invariably, e.g., the cost of GSM usage is the single most important demand driver (Eutelis, 1993).

It is broken down into the monthly fee and the usage cost per minute. Telecommunication analysts unanimously predict that the GSM usage fee will continue to decline due to economies of scales, maturation of the networks, and increased competition resulting from market liberalization.

Product quality (PROD-QUAL): Product quality remains a prevalent factor in affecting consumer demand of information technology (Bacon, 1992). It consists of network quality, service quality, and terminal or handset quality. GSM is still in the growth phase; as for any new product, its quality is a critical factor for consumers. Product quality probably helps boost the demand for GSM during the introductory phase, but the boost is likely to weaken over time.

Information about GSM (INFO_VOL): This factor is known in the marketing literature as communicability of product benefits (Rogers, 1993). This factor relates to the extent to which information about GSM promotes or harms GSM demand.

GSM impacts on private lifestyle (PRIV_LIFE): Reachability also affects GSM users in their private lives. GSM brings convenience to social interaction; at the same time, in certain situations, it can become disruptive and annoying (Dordick, 1989; Halal, 1992). This argument extends to the context of personal safety in that GSM can provide a person in need with a way to get immediate help.

GSM impacts on business practices (BUS_LIFE): The impact of cellular communication on business practices is in essence similar to that of the phone. GSM use is expected to have stronger and more positive externalities than other telecommunication services. As the capacity of the network increases with new GSM subscribers, the utility of a GSM user will increase as he is able to communicate with more people.

Alternative technologies (ALT_TECHNOS): GSM is a newcomer in the communications industry. Depending on the country considered, it will be mainly supplemented by foreseeable integrated products and services (Germany) or it will have to compete with alternative fixed and mobile infrastructures (Hong Kong and Vietnam). Consequently, the GSM demand partially depends on the development of alternative technologies (Jarrat and Coates, 1990). While GSM brings more flexibility, wired communication is cheaper and still more reliable, particularly for large data transfer.

Availability of a GSM evaluation framework (EVAL_POSSI): The cost-effectiveness of a new technology is difficult to estimate (Bacon, 1992). Hence, an evaluation framework justifying the acquisition and use of GSM is often replaced by

user's faith in the benefits that he expects a new technology to bring to the organization.

The factors considered here show a unique departure from a large and traditional body of literature that models telecommunication demand according to price and income elasticities of telecommunication services. Research in the mobile phone sector has exclusively been focused on the market supply (Eutelis, 1993). These studies focus on GSM growth factors such as country size, population size, GNP, liberalization policy, year of GSM introduction, etc., thus ignoring the fundamental aspects specific to market demand. Also, they offer little or no information about factors related to the comparability across political and cultural boundaries.

2.2 Modeling the GSM Market using System Dynamics

System dynamics provides a modeling framework for understanding the dynamic interrelationships between the elements of a system rather than the static snapshots of elements (e.g., Forrester, 1970). System dynamics has been chosen for the GSM model for the following specific reasons. First, system dynamics has proven its effectiveness for long-range planning and simulation of modeling problems driven by a high degree of feedback loops between intervening forces. Second, system dynamics emphasizes intuitive understanding of the mathematics underlying dynamic systems. The behavior of a system is regarded as a consequence of the developments of integrated causal relations.

Thus, this paper proposes a simulation model for the GSM market demand covering a ten year period, i.e., until the year 2005. Our primary goal is to analyze the dynamics of the factors that drive users over time; our secondary objective is to estimate the total of number of GSM users. The model seeks to integrate and capture the seven factors described above to derive the number of users (USERS) over time on a quarterly basis. Central to our model is the dynamic feedback that is represented in a simple circular structure. The demand factors influence USERS, and in turn, USERS drives the factors. The goal of the proposed model is not to make precise quantitative predictions, but rather to uncover the trends of key interrelated decisions.

3. THE GERMAN GSM: BACKGROUND AND SIMULATION RESULTS

3.1 Data Collection and Model Validation

The German model was developed based on statistical analyses and field interviews with local experts in telecommunication, wireless

communication, and GSM. Senior highranking executives of network operators, service providers, and industry analysts were interviewed at length. They provided historical data and marketing study results for all seven factors. More important, they provided opinions with regard to the trends of telecommunication policies, pricing, and market demand in general based on market surveys, discussion among GSM industry specialists, and personal experience. The model was built to depict future trends and their dynamic interrelationships. Many iterations were required based on the experts' feedback until the revised models provide satisfactory answers to experts. The model was built based on actual data up to December 1994. Later data were used to test the goodness of fit of the models.

3.2 Country Background

Germany has a population of 80 million. After the reunification of the former East and West Germanies, massive investment projects were launched to build infrastructure in the East. Telecommunication is already the second largest industry segment in Germany. Eutelis expects the market share of GSM within the mobile segment to fall between 35-60 % by the year 2005 (Eutelis, 1993).

GSM has been introduced in Germany in July 1992 by two network operators. Since then, several more providers have been in the market. Three main factors pushed the demand for the network during 1991-92: (i) Monthly fees were reduced from US\$75 to US\$49, (ii) the cost for an average handset dropped from about US\$7,500 to ñUS\$1,875, and (iii) the mediocre telecommunication infrastructure in the "New Laender" (former Eastern Germany) meant that the wireless phone was often the only reliable means of telecommunication

3.3 Simulation Results

In the case of Germany, the time of modelling starts from July 1992 and extends to December 2005. Prediction extends from January 1995 until December 2005. The simulation results reflect a steady increase of GSM users in Germany, predicting reaching a maximum of 19.4 million users in 2003. The upward trend is, however, not linear. Demand grows exponentially during the first years after the introduction of the technology, and then it follows the cascaded shape of the cost curves. As a new technology, GSM is perceived as a complement of existing telecommunication infrastructures. This observation is further supported by scenario analyses revealing that consumers are more sensitive towards cost deductions than towards absolute cost levels.

The improvement in product and service quality is the leading factor for GSM demand besides costs. The increase in PROD_QUAL during the first quarters in Germany refers mainly to the improvement of future value-added services. Within the first two years, coverage has reached over 90 %. As the quality improves over time, its impact is apparent.

An increasing number of service providers enlarges the range of services and of pricing schemes offered. Major trends of concentration in the service provider sector are expected to reduce the variety of services offered slightly. Furthermore, service providers remaining in the market will most likely be characterized by a stronger economic condition due to economies of scales, gains in management expertise, and sound financial backgrounds.

The diffusion of information about GSM helps to push the market until 1995-1996 and then declines in its impact. In the medium and long run the impact of INFO_VOL is expected to decrease drastically for three main reasons: (i) advertisements will shift its target away from product announcement campaigns to advertising for a familiar commodity, (ii) word-of-mouth will lose its impact as most people will be aware of the technology, and (iii) the frequency of publications, in parallel with the public's decreasing interest, will also drop. Additionally, it is realistic to expect that unfavorable news will appear, reducing the positive impact of the INFO_VOL.

GSM is expected to have a tremendous impact on the private lives of both business and non-business people. This impact is expected to gain quickly and then, in spite of a minor decline, remain rather high. Especially, reachability and the need to feel secure, as intrinsic human characteristics, will continue to drive the popularity of GSM. The latter mainly refers to elderly and sick people who will adopt GSM as part of their communication requirements. An example of the impact of mobile phone on private lifestyle is the fact that parents in Germany have begun equipping their children with wireless devices for security reasons.

Shortly after GSM introduction, the BUS_LIFE factor played a major role in GSM growth, driven by the perpetual needs of top executives to improve existing business activities and to search for new business opportunities. The behaviors of the PRIV_LIFE and BUS_LIFE are in essence similar.

Alternative Technologies are expected to be complementary in Germany. From the users' perspective, the distinction between fixed and mobile networks will be reduced within the coming years by features like integrated billing and card phones in the fixed network.

The impact of EVAL_POSSI is closely related to that of BUS_LIFE. Companies that consider GSM as a technological means to support their (innovative) business procedures try to perform cost-benefit analyses to find the most promising infrastructure investment.

4. CONCLUSION

The purpose of this paper is to study the demand of GSM. Although GSM is only one of the pieces in the cluster of current and future telecommunication networks, its ability to provide 'anytime-anywhere communication', will continue to push demand higher. In response to this new and booming technology, the world-wide market is growing rapidly, with no saturation expected in the short term. However, our model suggests that the impact of mobile telecommunication will dynamically alter the demand in the long run. Increasing GSM use will certainly influence many people's professional and personal lives. In turn, these changes will alter the development and usage of GSM. This research contributes to the understanding of the relative importance of the demand factors. The simulation shows the pronounced effect of cost on GSM demand. It also confirms the prevailing impression that the quality of the GSM network, the handsets, and the value-added services are important to sustaining demand over time.

5. REFERENCES

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