Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 12 (2014) 535 – 541

Procedia Technology

The 7th International Conference Interdisciplinarity in Engineering (INTER-ENG 2013)

Analytical investigation of mobile NFC adaption with SWOT-AHP approach: A case of Italian Telecom

Fahad Mehmood[a,]*, Mohammad Hassannezhad[a], Tahir Abbas[b]

[a]*Department of Management and Production Engineering, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy*
bFaculty of Material Science and Engineering, GIK Institute of Engineering Sciences and Technology, Pakistan

Abstract

The purpose of this study is to appraise the critical factors in near field communication (NFC) adoption process and to utilize findings in order to support launching NFC implementations in Italy, by means of applying a combination of SWOT and AHP approaches. Hence, a set of twenty SWOT factors is identified qualitatively through extended interviews with telecommunication experts as well as exploratory studies on case which are supported by quantitative investigation through pair-wise comparisons matrices as an application of AHP approach. However, this combined methodology enables us to describe NFC adoption process, providing guidance to clarify the critical factors during adoption process. As the first application of joint SWOT and AHP approaches in telecommunication networks, managerial perceptions are promising either for policy makers concerning NFC or further academic researches on NFC application and full scale deployment in market.

Selection and peer-review under responsibility of the Petru Maior University of Tirgu Mures.

Keywords: Near field communication NFC; SWOT; AHP; adoption process; decision making.

* Corresponding author. Tel.: +39-011-0907227 ; fax: +39-011-5647299
E-mail address: fahad.mehmood@polito.it

2212-0173 © 2013 The Authors. Published by Elsevier Ltd.
Selection and peer-review under responsibility of the Petru Maior University of Tirgu Mures.
doi:10.1016/j.protcy.2013.12.526

1. Introduction

During recent years, mobile phones have become our ubiquitous friends and are perhaps the most common itinerant computing devices, playing an important role socially, emotionally and recreationally. The innovations in communication networks particularly mobile phones technology have made it prone for a broad range of applications [1]. Nowadays, near field communication (NFC) service, as one of the most recent technologies in telecommunication area, is going to be developed around the world through transformation from initial testing to full scale deployment. Near field communication (NFC) is a contactless technology which enables communication between two devices using electromagnetic fields[†]. Such a communication can not only be used for payments or data exchange [2] but also other kind of applications like establishing Wi-Fi connection. NFC is important because companies and decision makers must make use of innovative new methods for secure information and data transfer while providing high level of technological novelties to customers to achieve competitive advantage in challenging global competition.

On national level, a proficient and secure electronic payment system can be helpful for Italian economy, as the costs related to cash handling can be reduced. According to study by Humphrey et al. [3], a shift to electronic payments can result in substantial cost savings as the costs related to cash handling accruement to 3 percent of a country's GDP. So it is imperative for Italian companies to provide innovative solutions to customers in order to remain competitive in market. A convenient and swift electronic payment is one of the advantages provided by NFC. From adaption process viewpoint, NFC has a high potential to reach the market saturation level due to high penetration rates of mobile devices, but this has been recently a controversial issue for policy makers the diffusion process of NFC, especially in a manner that the literature in this paradigm is rather poor which can be interpreted whether academically or practically. In this research, according to adaption process of mobile networks, principle functions of mobile NFC will be investigated qualitatively and quantitatively in order to support decision makers in different socioeconomic aspects by making a better understanding of market potentials, giving some informative managerial insights.

By means of NFC, it would be possible to provide so much benefits between smartphones and also similar devices in such areas like; payment of bills (Google Wallet), electronic ticketing, setting up Wi-Fi/Bluetooth connections (Wi-Fi Direct), social networking and potential usage in identity cards and smart posters[‡]. The maximum profit on making possibilities of NFC include applications for ticketing, mobile payment and authentication which is mirrored by accomplished trials of companies working on NFC technology like Nokia, Japan's Telecom operator NTT DoCoMo among other applications for payments and ticketing [4]. Moving into this progress, in Italy, initially the electronic ticketing pilot was implemented earlier [5]. However, financial institutions as well as telecommunication sectors are planning to launch NFC services eagerly. A leading telecommunication company in Italy plans to provide NFC enabled services to market and installed a pilot project. A thorough analysis of this project will be helpful when NFC services are launched on a large scale. This study utilizes the SWOT-AHP methodology to determine the most effective factors in NFC technology which will be useful in analyzing the adoption potential of NFC. This paper is organized as below; following the introduction described before, in section 2, we will begin by describing the principles of SWOT-AHP approach. Section 3 discusses the research methodology utilized as well as data collection procedure. In section 4, results will be analysed and discussed following the research questions and finally, the paper will be concluded in section 5.

2. SWOT and AHP

Strengths, Weaknesses, Opportunities, and Threats [SWOT] analysis scrutinizes strengths and weaknesses of a product internally and highlights the opportunities and threats of the external environment [6]. The basic drawback

[†] NFC Forum: "About NFC [online]", Available from: http://www.nfc-forum.org/aboutnfc/, Accessed: 12th June, 2013.
[‡] NFC Forum: "Smart Posters", April, 2011,
Available from: http://www.nfc-forum.org/resources/white_papers/NFC_Smart_Posters_White_Paper.pdf

of this approach is that it cannot be used to quantitatively compute the impact of each individual factor. So, it is difficult to evaluate which factors have greater impact on the final strategic decision [6].

Analytical hierarchy process (AHP), proposed by Thomas L. Saaty is such a method for structured analysis of a complex decision [16]. For many years, this approach has been studied and applied extensively especially in multi-criteria decision making (MCDM) problems. Performance of AHP is related to hierarchy structure and paired comparisons of decision components.

Hence, in order to solve technical limitations of SWOT due to the lack of quantitative analysis, SWOT-AHP hybrid method introduced by (Kurttila et al., 2000) resulting in increase on usability for primary SWOT [7]. SWOT-AHP approach has been applied in different fields like tourism [8], forestry [7, 9], agriculture [10] and manufacturing [11]; but to our knowledge, this is the first application of combined SWOT-AHP approach to Telecommunication sector with focus on practical relevance of NFC. The progress of our research would be as follows: (1) SWOT analysis, (2) pair-wise comparisons among SWOT factors within each SWOT group, (3) pair-wise comparisons between the four SWOT groups, and (4) a strategy formulation from the results.

3. Research methodology and data collection

Considering to the research goals, an integrated methodology utilized including SWOT and AHP approaches jointly in two stages alternatively. Doing this, major functions of leading Italian Telecom on mobile NFC area first identified based on qualitative analysis through exploratory study of Telecom Company in Turin, consisting of; reviewing the company documents in the case of mobile NFC and extended personal interviews with managers and experts in order to determine the strengths, weaknesses, opportunities and threats of the case. The resulting SWOT matrix is shown in Fig. 1.

Strengths *What strengths do we have?*	**Weaknesses** *What weaknesses do we need to remove?*
S1: High diffusion rate S11: Penetration level of mobiles S12: Economies of scale **S2: High compatibility** S21: NFC compatible to use on mobiles S22: Range of NFC applications (e.g. smart tags) **S3: Ease of use** S31: Ubiquitous companions S32: Faster and more convenient	**W1: Adverse effect on phone** W11: Reduction in battery life **W2: Security/privacy risks** W21: Virus attacks or hacking W22: Information misuse **W3: Costs** W31: Phones with NFC cost more W32: Infrastructure deployment costs W33: Service costs
Opportunities *What opportunities can we utilitize?*	**Threats** *What threats do we need to be aware of?*
O1: Technology Innovation O11: Innovative technology (e.g. customer loyalty) O12: First mover advantages **O2: Other business opportunities** O21: Strategic partnerships O22: Increase in customer interaction	**T1: Threats related to new technology** T11: Lack of business models T12: Lack of laws and regulations T13: Reluctance of change **T2: Competition** T21: Competition with other technologies

Fig. 1. SWOT matrix of mobile NFC

After analyzing the SWOT factors, a questionnaire made using combined SWOT-AHP methodology. The survey incorporated a scale to evaluate the pair-wise comparison of SWOT factors with respect to each other (Fig. 2). The experts asked to specify more efficient factors and then determine the relative importance based on their weights. This method of pair-wise comparisons using a scale firstly proposed by Saaty in 1977 [12]. During the pair-wise comparison of service cost versus infrastructure cost, for example, the expert would first decide which of these two factors is more important, and then allocated a weight ranging from one to nine in order to identify the relative importance of each factor. Similarly, all factors weighted by dedicating them proper rates in comparison to other factors.

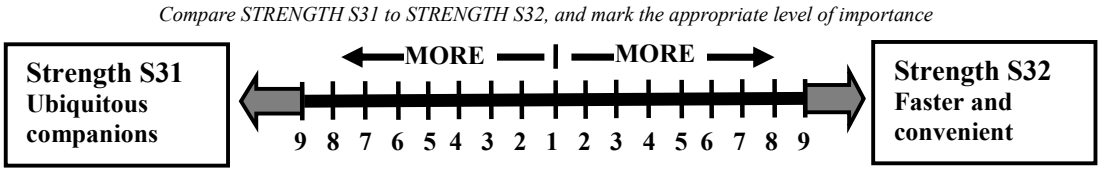

Fig. 2. Sample of questionnaire for pair-wise comparisons

Once all the factors were compared, priority values for all factors computed by utilizing *Eigen Value* method. This method was utilized by Saaty [16] to produce a pair-wise comparison matrix and to form a priority weight vector. Exclusively, for the purpose of computing priority values, the resulting pair-wise comparisons were characterized by a reciprocal matrix with weights represented by a_{ij} and the reciprocal shown on opposite side of diagonal by $1/ a_{ij}$.

$$A = a_{ij} = \begin{bmatrix} w1/w1 & w1/w2 & \cdots & w1/wn \\ w2/w1 & w2/w2 & \cdots & w2/wn \\ \vdots & \cdots & \ddots & \vdots \\ wn/w1 & wn/w2 & \cdots & wn/wn \end{bmatrix} \quad (1)$$

In matrix A, rows represent the relative weight of each factor in comparison to the others (Eq. (1)) and also when $i = j$, $a_{ij} = 1$. When we multiply the transpose of the vector of weights w by matrix A, we get a vector represented by $\lambda_{max}w$,

$$(\boldsymbol{A} - \lambda \boldsymbol{I})\boldsymbol{w} = 0 \quad (2)$$

In Equal (2), I is the identity matrix and $\lambda=\lambda_{max}$. However, it is essential for consistency that λ_{max}= n and greater values of λ_{max} differs to that of n, while greater will be inconsistency in responses of pair-wise comparisons. Therefore, we must use the following formula;

$$\boldsymbol{CI} = (\boldsymbol{\lambda max} - \boldsymbol{n})/\boldsymbol{n} - 1 \quad (3)$$

$$\boldsymbol{CR} = \boldsymbol{CI}/\boldsymbol{RI} \quad (4)$$

Where *CR* is the consistency ratio, *CI* is the consistency index, and *RI* is the consistency index of a random matrix of order *n*. *CR* should be maintained less than 10% and if it is above 20%, then re-evaluation must be performed, according to references [12, 13, 14]. The next step is to calculate the overall priority of each factor by multiplying the individual priority of each factor to scaling factor calculated for each group of SWOT. The scaling factor of each group calculated using the *Eigen Value* method already discussed.

$$Global\ priority\ of\ factor_{ij} = (priority\ value\ of\ factor_{ij}) \times (scaling\ value\ of\ SWOT\ category) \quad (5)$$

There is a basic assumption involved in this formula that the groups are independent of each other. For example, importance of strengths relative to opportunities does not depend on whether or to what extent weakness are diminished by capitalizing on strengths [15].

4. Results and Discussion

A total of 23 questionnaires were filled by experts in Telecommunication sector who had acceptable knowledge about NFC. The data acquired from the experts examined to calculate factor priority and overall priority scores (Table 1). Factor priority scores show the relative importance of individual factor in the same group whereas overall priority scores represent the relative importance of them across the SWOT matrix. As proposed by Saaty [12], the consistency ratios are maintained <0.1 during our analysis.

Table 1. Final weight scores for SWOT factors based on SWOT-AHP analysis

SWOT group	Group weight score	SWOT factors	Local weight score	Overall weight score
Strengths	0.477	S11: Penetration level of mobiles	0.418	0.1994
		S12: Economies of scale	0.210	0.1002
		S21: NFC compatible for use on mobiles	0.175	0.0835
		S22: Can be used for other functions	0.052	0.0248
		S31: Ubiquitous companions	0.045	0.0215
		S32: Faster and convenient	0.100	0.0477
Weaknesses	0.239	W11: Reduction in battery life	0.143	0.0342
		W21: Virus attacks or hacking	0.236	0.0564
		W22: Information misuse	0.374	0.0894
		W31: Phones with NFC cost more	0.112	0.0268
		W32: Infra-structure deployment costs	0.095	0.0227
		W33: Service costs	0.040	0.0096
Opportunities	0.198	O11: Innovative technology (Customer loyalty)	0.390	0.0772
		O12: First mover advantage	0.117	0.0232
		O21: Strategic partnerships	0.175	0.0347
		O22: Increase in customer interaction	0.318	0.0630
Threats	0.086	T11: Lack of business models	0.244	0.0210
		T12: Lack of laws and regulations	0.216	0.0186
		T13: Reluctance of change	0.137	0.0118
		T21: Competition with other technologies	0.403	0.0346

Analyzing the table indicates that the *penetration level of mobile* is the most important strength factor (0.418) followed by *economies of scale* (0.210). This result shows the importance of mobile diffusion rate on the adoption process of NFC. The most serious weaknesses are related to privacy as expected. *Information misuse* (0.374) and *hacking/virus attacks* (0.236) are major weaknesses in the NFC adoption. According to experts' perception, NFC being an *innovative technology* with the potential to attract customers is the biggest opportunity that can be capitalized (factor priority score 0.39). Moreover, *competition with other technologies* (0.403) such as QR codes or credit cards for payments is the main threat.

Across the group examination reveals that according to responses, strength group is most influential on NFC adoption decisions with group weight score of (0.477), according to Table 1, and Weakness group is the following (0.239). The overall priority score of each factor is calculated by multiplying factor by group priority scores. For

instance, the overall priority score, (0.0342), for reduction in battery life is the product of its factor priority score (0.143) and weakness group priority score (0.239).

The overall priority scores are represented in graphical framework, as shown in Fig 3. The values in each group have to be represented in absolute terms. The graphical representation reveals that the internal factors (strengths and weaknesses) are more important to experts on making decisions related to NFC in comparison to external factors of opportunities and threats. The length of line in each quadrant represents the overall importance of each group while the points represent the overall priority of individual factors.

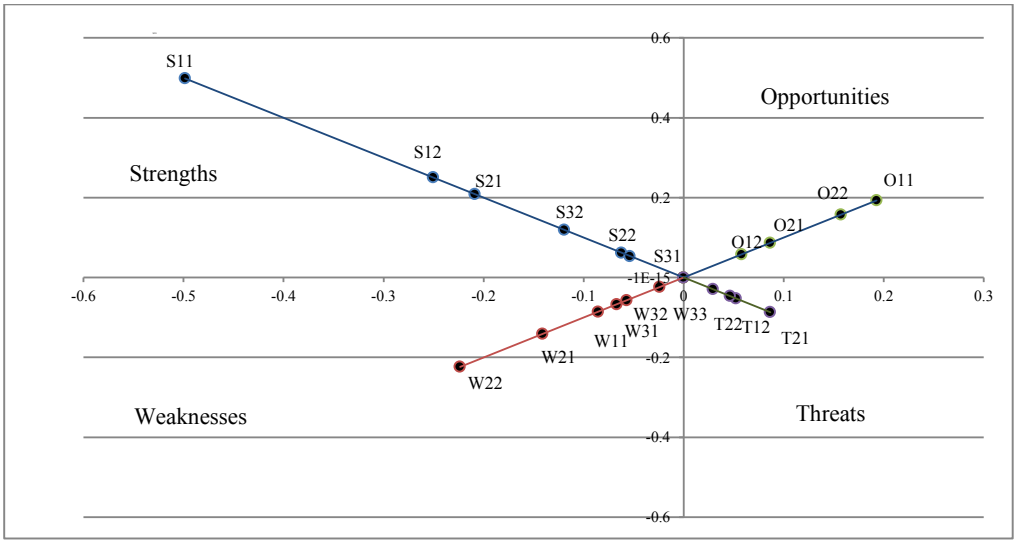

Fig 3. Graphical Representation of overall priority

5. Conclusion

This study utilizes the SWOT-AHP methodology to assess the importance of external and internal tribulations and positive outlooks related to NFC adoption in Telecommunication industry which can be used further by decision makers to make strategies for deployment on a large scale. A systematic and analytical approach used in order to address an under developed research paradigm in NFC literature. Our findings indicate that according to telecommunication experts, the positive factors (strengths and opportunities) associated with NFC are potentially more important than the negative factors (weaknesses and threats). This represents the positive prospects related to NFC projects that can be developed in the near future. Moreover, the results also show the dominance of internal factors (strengths and weaknesses) over external factors (opportunities and threats). Application of combined SWOT-AHP approach to one telecommunication company can be interpreted as the main limitation of our study thereby caution should be taken on developing the results; however, gathering richer data through interviews or in the form of mail-questionnaires would be beneficial which is the basis of our next step investigating this field.

However, when NFC will become mass market remains to be seen as there are conflicting reports in this area but based on this study, future prospects on NFC appear to be strong according to telecommunication decision makers. The extremely high penetration level of mobile phones along with compatibility features of NFC and innovation factors involved make it easy to use and attractive to customers. The biggest threat on this technology-based field would be competitive markets and the lack of standards in this filed. With the passage of time, as more and more companies invest in this technology along with pilot projects, there is a greater possibility of well-defined business models as well as the emergence of standards. Nevertheless, NFC offers much more than only the possibility of contactless payments as it offers much more applications and services linking together various industries to form strategic partnerships and win-win situations. Consumer product strategists must take into account the entire ecosystem and not focus only on one aspect of NFC. With continued research in this technology, weaknesses such

as security/privacy can be overcome and will give strategists a greater opportunity to use the strengths and capitalize on opportunities offered by NFC.

References

[1] Goggin G. Cell Phone Culture: Mobile Technology in Everyday Life. Oxen: Routledge; 2006.
[2] Curran K, Millar A, Garvey CM. Near Filed Communication. International Journal of Electrical and Computer Engineering 2012; 2(3): 371-382.
[3] Humphrey DB, Kim M, Vale B. Realizing the Gains from Electronic Payments: Costs, Pricing and Payment Choice. Journal of Money, Credit, and Banking 2001; 33(2): 216-234.
[4] Falke O, Rukzio E, Dietz U, Holleis P, Schmidt A. Mobile Services for Near Field Communication. Technical Report. Retrieved on 15 June 2013 via; http://www.mmi.ifi.lmu.de/pubdb/publications/pub/falke2007mobileServicesTR/falke2007mobileServicesTR.pdf.
[5] Ghiron S, Sposato S, Medaglia C, Moroni A. NFC Ticketing: A Prototype and Usability Test of an NFC-Based Virtual Ticketing Application. In: Proc. of First International Workshop on Near Filed Communication, 45-50, Hagenberg, Austria; 2009.
[6] Pesonen M, Kurttila M, Kangas J, Kajanus M, Heinonen P. Assessing the priorities using A'WOT among resource management strategies at the Finnish forest and park service. Forest Science 2000; 47(4): 534-541.
[7] Kurttila M, Pesonen M, Kangas J, Kajanus, M. Utilizing the analytic hierarchy process (AHP) in SWOT analysis—a hybrid method and its application to a forest certification case. Forest Policy and Economics 2000; 1(1): 41-52.
[8] Kajanusa M, Kangasb J, Kurttila M. The use of value focused thinking and the A'WOT hybrid method in tourism management. Tourism Management 2004; 25 (4): 499–506
[9] Michel K Masozera, Janaki RR Alavalapati, Susan K. Jacobson, Ram K. Shrestha. Assessing the suitability of community-based management for the Nyungwe Forest Reserve, Rwanda. Forest Policy and Economics 2006; 8(2): 206-216.
[10] Ram K. Shrestha, Janaki R.R. Alavalapati, Robert S. Kalmbacher. Exploring the potential for silvopasture adoption in south-central Florida: An application of SWOT-AHP method. Agricultural Systems 2004; 81(3): 185–199.
[11] Shinno H, Yoshioka H, Marpaung S, Hachiga S. Quantitative SWOT analysis on global competitiveness of machine tool industry. Journal of Engineering Design 2006; 17(3): 251–258.
[12] Saaty, T. A scaling method for priorities in hierarchical structure. Journal of Mathematical Psychology 1977; 15(3): 234–281.
[13] Mawapanga MN, Debertin DL. Choosing between alternative farming systems: an application of the analytic hierarchy process. Review of Agricultural Economics 1996; 18(3): 385-401.
[14] Margles SW, Masozera M, Rugyerinyange L, Kaplin BA. Participatory planning: Using SWOT-AHP analysis in buffer zone management planning. Journal of Sustainable Forestry 2010; 29 (6): 613-637.
[15] Jonathan Catron, G. Andrew Stainback, Puneet Dwivedi, John M. Lhotka. Bioenergy development in Kentucky: A SWOT-ANP analysis. Forest Policy and Economics 2013; 28(6): 38-43.
[16] Saaty, T. The Analytic Hierarchy Process. McGraw-Hill: New York; 1980.