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Performance Evaluation of Digital Marketing in Health Care Industry with the Application of Data Envelopment Analysis

Zhi-Wang QIAN¹, Guang-Sheng WAN², Xiao-Lei DU³, Yu-Feng SHI⁴, Gang HUANG⁵

Abstract

The competition in health care industry is getting fierce. How to take health care quality, cost effectiveness, and business performance into account and adopt correct strategies to achieve the vision and sustained-yield management is the problems current hospitals would encounter. For this reason, the integration of resources and the investment in marketing are the top priority. From the digital marketing data in health care industry in Shanghai, 12 hospitals are taking as the research subjects in this study. The research results are summarized as follows. One DMU presents strong digital marketing efficiency, with the efficiency=1, revealing better digital marketing efficiency. Six DMUs shows the digital marketing efficiency between 0.9 and 1, as marginal inefficient, that the digital marketing efficiency can be more easily promoted. Five DMUs, about 42% of all DMUs, present the digital marketing efficiency less than 0.9, as obvious inefficient, where Shanghai Municipal Hospital of Traditional Chinese Medicine appears the lowest digital marketing efficiency. According to the research results, it is suggested to lead health care industry to maintain the operation performance with innovative marketing and achieve the vision of sustained-yield management among the competitive medical environment.

Keywords: health care industry, digital marketing, performance evaluation, management, medical expenditure.

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Introduction

The improvement of global living environment and the boom of medical technology have generally promoted the living quality of humans and extended the average life. Nevertheless, the accompanied formation of aging population structure has resulted in increasing patients with chronic diseases and further become the national medical expenditure and social welfare burden for many developed or developing countries. The average lifetime in the world is significantly extended in the past decade because of the enhancement of knowledge and living standards, the expansion of preventive medicine, and most importantly the advance of medicine development and medical technology. Nonetheless, the rising medical expenditure becomes a primary issue for hospitals. Various hospitals therefore have proposed related coping measures to restrict the high growth of medical expenditure and reduced operation costs to maintain the operation. The integration of resources and the investment in marketing therefore are the top priority. To think of new marketing strategies under restricted conditions, the idea of digital marketing is slowly accepted and developed in health care industry, due to the popularity of Internet marketing platforms and faster message passing. The multiple channels for information acquisition also has health care industry start to utilize network platforms for internal meetings, establish training platforms for further internal services, provide instant messages to external customers to rapidly respond to customer requirements, and establish connection mechanisms to grasp more new opportunities for cooperation. In the fiercely competitive health care industry, how to take health care quality, cost effectiveness, and business performance into account and adopt correct strategies to achieve the vision of sustained-yield management is the current problems for hospitals. Although digital marketing has been preceded internationally, it has not been popular in domestic health care industry. Health care industry therefore starts to think of innovative marketing to maintain the operation performance.

Literature Review

Digital marketing

Digital marketing is an alternative marketing based on the essence of marketing. American Marketing Association (AMA) defined marketing as an organizational function to create, communicate, and deliver value to customers and manage customer relations, and the interested parties could acquire benefits (Kaufman, 2014). Kaufman & Horton (2015) pointed out digital marketing as a non-traditional marketing model. Generally speaking, marketing activity with information technology and digital tools could be digital marketing (Roopa *et al.*, 2015). Digital marketing was influenced by marketing, technology, and economics;

and, an enterprise could foresee and plan the network marketing structure according to the trends of digitization, networking, and personalization. Sanchez-Franco, Peral-Peral, Villarejo-Ramos (2015) defined digital marketing as the result of marketing evolution. The evolution occurred when a company used digital media channels for most of the marketing. Digital media channels could be addressed and allowed continuous, two-way, and personalized conversation between marketers and consumers. Atchison (2015) regarded marketing in digital era as e-marketing, i.e. the marketing activity of an individual or an enterprise delivering data, information, knowledge, and wisdom through digital tools and largely dumping to consumers through digitalization to further change the purchase decisions. Jiang Zuorong, the chief executive officer of Medialand Digital, regarded the characteristics of digital marketing as sticky and loyal media with high interactivity and small restrictions on production specifications; besides, it was the only one being accurately tested the effectiveness (Kevin, 2014). When discussing digital marketing, the difference with tradition marketing was often associated. Triguero *et al.* (2015) pointed out three characteristics of digital marketing, in comparison with traditional marketing. (1) High efficiency: Information tools could assist marketers in good standards and vertical integration. (2) Penetration: Various types of media and communication channels allowed marketers more easily contacting with potential customers. (3) Interactivity: Instant measurement of information could have potential customers acquire more precise and personalized responses to the needs (Kevin, 2014).

Chen *et al.* (2013) mentioned the following characteristics used for the rapid development of digital globally (Jason, Robyn, & Nathaniel, 2013): (1) Low technical threshold: The “publication” process was simplified to individual easy creation so that blogs could be easily used without the technological capability of webpage programming design; (2) Personalized cross-platform interaction: Blogs allowed users easily and randomly dominating the text, connection, picture, music, and even video construction to achieve the media spirit and layout autonomy; (3) Immediate release and sharing: Blogs allowed releasing instant messages, publishing author opinions and ideas on the Internet, and exchanging with like-minded netizens; (4) Multiple applications: The multiple contents contained politics, life, network technology, literature, and art comment; besides, blogs could be utilized for producing network photography and news blogs.

Performance evaluation

Kargarfard, Sami, A., & Ebrahimie (2015) defined organizational performance as “the attainment of a specific desired end”. In other words, performance was the consistency between the actual output and the desired output of an organization. However, the setting of “desired objective” became the dispute among organization theory scholars. The purpose of business performance measurement was a manager inspecting the goal attainment of the organization to judge the corporate

performance. Since the idea of business performance is huge and abstract, the changeable measurement standards are generally classified into financial indicators (e.g. return on investment, return on sales, and revenue growth rate) (Damian, 2014) and non-financial indicators (e.g. customer satisfaction, new product launch or strategic goal attainment, employee efficiency, and R&D of product process) (Garris, 2014). Generally speaking, the theoretical model of performance is divided into the following three models (Jones, 2013): (1) *Goal model*. In this model, an organization is assumed a rational system which, according to objective environment and real requirements, would make practicable measures according to the capability and resources as well as integrate and coordinate organizational resources to effectively complete various organizational objectives; (2) *System model*. Sheth & Thirunarayan (2013) indicated that, under system model, an organization was regarded as a system, which received resource input from external environment, processed and transformed resources, and output to external environment with a different form. Through such an “output, transformation, output” process, the organization presented the capability to acquire resources and output to the environment. The organizational performance therefore relied on the balance between resource input and output; (3) *Participation-satisfaction model*. Organization member satisfaction was emphasized that it was considered that the success of an organization was not the attainment of organizational goals, but individual performance in the organization. It was considered in this model that an organization could survive depending on individual contributions in the organization. In this case, performance should be individual satisfaction and subjective perception.

Lau *et al.* (2013) classified organizational performance into financial performance and operation performance. The former utilized output-based financial indicators for measuring the attainment of economic goals, such as sales growth, return on investment, and earnings per share. The latter, also called non-financial performance, was the evaluation indicator to measure technical efficiency, such as market share, new production introduction, product quality, and added-value creation. There were multiple standards for the evaluation with financial indicators. According to the research subjects and coverage, a single concept could also be applied, such as return on assets (ROA), return on sales (ROS), return on equity (ROE), and sales growth (Hritzuk, 2014).

Data Envelopment Analysis

Turel, Connelly, & Fisk (2013) mentioned that the evaluation of efficiency was an important issue in management and efficiency evaluation was the core of cost control. An effective efficiency evaluation could assist a department in enhancing the efficiency of resource investment and product output, i.e. producing the most products with the least resources. In other words, a good evaluation model could calculate the overall efficiency to present the resource use. Besides, it could

evaluate with qualitative and quantitative data and various units of measurement, process multiple inputs and outputs as well as external environmental variables, and avoid subjective factors in the weight setting so as to assist a decision maker in making decisions.

Verhoef & Lemon (2013) indicated that the basic concept to measure efficiency with DEA was based on the efficiency of “Pareto optimality”. The so-called Pareto optimality revealed that no one could enhance another person’s benefits without damaging others’ benefits. With the idea of envelope, the input and output of all decision making units (DMU) were taken into account in DEA, and the weighted output was divided by the weighted input to calculate the relative efficiency of an individual firm to other firms. According to the efficiency concept, the actual production and the production frontier could be compared, when “production frontier” (i.e. the concept of envelope or efficiency frontier in economics) was known, to further measure the efficiency.

Dana, Dawes, & Peterson (2013) expanded the method of Ferrel and established a general linear programming model to measure the production efficiency with multiple inputs and outputs under constant returns to scale; it was called Data Envelopment Analysis. The first proposed DEA model was then named CCR model. The basic model of Data Envelopment Analysis was based on three important production assumptions: (1) Constant returns to scale. Even when the operation scale was increased, the rate of return would not increase or decrease; (2) Constant marginal productivity. Regardless of the production, increasing a unit of input would increase the same output; (3) Fixed resource waste rate. When an institution appeared bad efficiency, the wasted input resources would appear fixed ratio.

Delphi Method and Modified Delphi Method

The practice of Delphi Method combines the advantages of group expert opinions to avoid the situational pressure caused by face-to-face discussions. Jill (2014) therefore proposed eight situations suitable for Delphi Method. (1) Little information offered for the research question and the uncertainty was high. (2) No accurate analysis technology was available for the research question, but subjective judgment data could be collected as the answers. (3) Participants might be capable of providing useful opinions for broad and complicated issues, but lacked interaction and discussions with other participants; or, the distinct specialties and experiences required exchange. (4) It required many people offering discussion opinions for the issue. Face-to-face conversation would achieve effective interaction, but might limit the number of participants. (5) It was difficult to arrange time and location for face-to-face meetings, and the large amount of expenses should be taken into account. (6) Efficient interaction, without being affected by the propagation of secondary groups, was necessary for opinion exchange between individuals and groups. (7) It was likely to induce unhappiness in the meeting process because of

different opinions and positions. An arbitration mechanism therefore was required in the group communication process to ensure the participants' anonymity. (8) Participants' heterogeneity should be remained in order to prevent the variability of research conclusion from being influenced by the advantage of majority opinion and individual personality traits.

Hsu, Wang, & Chih (2013) also pointed out four limits for Delphi Method. (1) Delphi Method relied on experts' intuitive knowledge, while the research result was easily interfered by experts' subjective judgment. (2) The practice of Delphi Method was organized by the tester that it might be interfered by the tester. (3) Testing with Delphi Method was time consuming and could hardly control the time that expert opinions might appear contradiction. Besides, testing subjects with low participation motivation might quit the test in the research process. (4) The final conclusion, with Delphi Method, was general and could not know the detailed planning and specific details that it could merely be the guidance and reference for making strategies. According to the research of Masiakowski & Wang (2013), brainstorming open-ended questionnaire in some part of the research was omitted due to special considerations. After referring to large amount of literatures and making revision, a structural questionnaire was directly developed for the first run questionnaire survey. It was Modified Delphi Method. Directly using the structural questionnaire for the first run survey in Modified Delphi Method could save a lot of time and have experts immediately pay attention to the research topic, without making guess on the open-ended questionnaire.

Research Design

Suitable inputs and outputs should be selected for effectively evaluating the effectiveness of digital marketing of DMUs in health care industry with DEA. Fuzzy Delphi Method is utilized for selecting inputs and outputs so as to combine expert opinions, reduce input costs, and avoid fuzziness in the survey process. Total 30 copies of questionnaires are distributed in this study, and 20 valid copies are collected, with the retrieval rate 67%. Hsu, Wang, & Chih (2013) indicated that the public opinions of more than 5 participants could be the analysis reference. The surveyed experts cover industry, official, and university and show frequent interaction with digital marketing in health care industry that certain representativeness is revealed.

With the calculation of Fuzzy Delphi Method, the geometric mean is regarded as the experts' consensus of the input/output evaluation. The median of the input/output evaluation is regarded as the standard to select inputs and outputs for measuring the digital marketing in health care industry. Four input/output variables, and, with strict selection, total 9 DMUs are used in this study.

All variable data used in this study are acquired from public prospectuses and annual reports.

The variables are defined as below.

1. Input variable: (a) Setup costs: Digital marketing equipment cost; (b) Administration expenses: Expenditure for practicing digital marketing.
2. Output variable: (a) Business performance: Gross sales– sales return and allowance; (b) Medical number: Number of people for health care in hospitals.

Empirical Analysis of Digital Marketing Performance in Health Care Industry

Analysis of digital marketing performance in health care industry

By substituting various input/output indicators into CCR model and BCC model, the overall production efficiency and pure technical efficiency of digital marketing of the hospitals are calculated. The returns to scale of the hospitals could be acquired by dividing both efficiency values. The overall production efficiency, pure technical efficiency, scale efficiency, and returns to scale are organized in *Table 1*. From Table 1, Children’s Hospital of Shanghai, with the overall efficiency=1, is relatively efficient, while the rest hospitals reveal low overall production efficiency; especially, Shanghai Municipal Hospital of Traditional Chinese Medicine appears the lowest overall efficiency that it is relatively inefficient. In other words, except the DMU with the overall production efficiency=1, the rest 11 DMUs are relatively inefficient, possibly because the inputs are not effectively applied or the optimum production scale is not achieved. It requires further analyses.

Table 1: Relative efficiency of digital marketing in health care industry

Hospitals In Shanghai City	Overall Efficiency	Technical Efficiency	Scale Efficiency
Children’s Hospital Of Shanghai	1.00	1.00	1.00
Shanghai Changzheng Hospital	0.88	0.87	0.89
Zhongshan Hospital	0.93	0.92	0.94
Shanghai First Maternity And Infant Hospital	0.82	0.83	0.81
Shanghai Mental Health Center	0.85	0.85	0.85
Xin Hua Hospital	0.90	0.91	0.90
Longhua Hospital	0.84	0.83	0.85
Shanghai Shuguang Hospital	0.93	0.94	0.93

Shanghai Municipal Hospital Of Traditional Chinese Medicine	0.76	0.75	0.77
Shanghai General Hospital	0.97	0.97	0.97
Shanghai East Hospital	0.95	0.94	0.95
Shanghai Huashan Hospital	0.90	0.91	0.90

Sensitivity Analysis

The risk evaluation in this study aims to analyze and find out the key factors in digital marketing in health care industry with Sensitivity Analysis. The input/output variables are removed one by one in DEA to understand the sensitivity to efficiency. The change rate of sensitivity is regarded as the evaluation criterion, and the sensitivity factors contain setup cost, administration expenses, business performance, and medical number. Accordingly, the research results are shown in Table 2.

- (1) After removing “setup cost”, the efficiency of all DMUs slightly reduces; that is, setup cost presents higher importance to all DMUs.
- (2) The efficiency of all DMUs is slightly lower than the original efficiency after removing “administration expenses”, revealing the higher importance of administration expenses to all DMUs.
- (3) The efficiency of all DMUs slightly reduces after removing “business performance”, showing that the higher importance of business performance to all DMUs.
- (4) The efficiency of all DMUs is slightly lower than the original efficiency after removing “medical number”, presenting the higher importance of medical number to all DMUs.

Table 2. Sensitivity Analysis of inputs and outputs removed one by one

DMU	Original relative efficiency	Remove setup cost	Remove administration expenses	Remove business performance	Remove medical number
Children's Hospital of Shanghai	1.00	0.98	0.97	0.99	0.90
Shanghai Changzheng Hospital	0.88	0.83	0.85	0.85	0.82
Zhongshan Hospital	0.93	0.89	0.90	0.91	0.88
Shanghai First Maternity and Infant Hospital	0.82	0.78	0.75	0.80	0.72
Shanghai Mental Health Center	0.85	0.80	0.77	0.83	0.76
Xin Hua Hospital	0.90	0.87	0.86	0.88	0.80
LongHua Hospital	0.84	0.82	0.80	0.80	0.76
Shanghai Shuguang Hospital	0.93	0.85	0.87	0.88	0.83
Shanghai Municipal Hospital of Traditional Chinese Medicine	0.76	0.74	0.73	0.75	0.74
Shanghai General Hospital	0.97	0.93	0.92	0.95	0.90
Shanghai East Hospital	0.95	0.90	0.91	0.92	0.89
Shanghai Huashan Hospital	0.90	0.85	0.87	0.86	0.80
Number of efficient DMU	1	0	0	0	0

Data source: Organized in this study.

Conclusion

From the efficiency and variable information from DEA, one DMU, about 8% of all DMUs, shows strong digital marketing efficiency, with the efficiency=1, revealing the better digital marketing efficiency. The digital marketing efficiency of six DMUs, about 50% of all DMUs, is between 0.9 and 1, as marginal inefficient, showing that the digital marketing efficiency can be easily promoted. Five DMUs, about 42% of all DMUs, are obvious inefficient, with the digital marketing efficiency lower than 0.9, where Shanghai Municipal Hospital of Traditional Chinese Medicine appears the lowest digital marketing efficiency. According to

the analysis results, it is inferred in this study that Children's Hospital of Shanghai is the first public hospital, among national pediatric hospitals, using the digital marketing platform and realizing various mobile medical services, e.g. online registration, for patients. The digital marketing service moves some functions which could be completed in the hospital to the digital marketing platform so that patients could complete at any place through mobile phones and precede online registration, waiting queue, expert appointment, and report query without leaving houses.

Recommendations

Aiming at digital marketing in health care industry, the following suggestions are proposed in this study.

- (1) Following the multiple developments and the maturity of multimedia, health care industry could present various marketing patterns. Such patterns could be propagated to the world through the advance of information technology and the ubiquitous characteristics of network. By integrating multiple multimedia with information in health care industry, the information could be presented with digital webpage guide for creative promotion of health care industry.
- (2) Digital marketing could timely solve users' needs in the mobile life that pure marketing is no longer applied to health care industry. Digital marketing is a marketing channel but would not merely show one marketing theory. In this case, how to use marketing bases and mobile thinking for effectively applying digital marketing to information contents, functions, and technologies to interact with users and effectively assist health care industry in delivering messages becomes critical. The digital marketing contents in health care industry therefore have to satisfy user needs by focusing on information contents and creating functions based on the assistance of technologies so that users could conveniently and rapidly use such contents.
- (3) Mainstream media are those used by most people that more consumers would be contacted to generate topics. Weibo, video sites, and mobile phones (or mobile devices) are the mainstream media at the moment. Digital marketing in health care industry therefore could be planned aiming at such media, rather than restricting on a single type. The combination of various types of digital marketing media could expand the marketing effect, contact consumers with distinct attributes, and further enhance the digital marketing efficiency, such as announcing detailed contents in the official website, posting short messages on Weibo and Plurk, or utilizing mobile phones APP for instant messaging.

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