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Research Article

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Presenting an efficiency analysis model of posts in social networks of digital marketing (Case Study: Facebook)

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Abstract

Today, there are several reasons for the necessity of using an enterprise resource planning system (ERP) more than ever. In the competitive environment of companies, components such as flexibility, quality, management of relationship with customers and lower cost show this necessity more colorfully. The necessity of integration in the processes of an organization, the need for ERP as one of the important and innovative decision-making and management tools increases the competitiveness of the organization. Since the application of ERP in the world has had many successes and failures, therefore, the efficient selection of one of the companies providing ERP can play a decisive role in the survival of organizations. In this article, considering standard KPIs, a method for selecting an ERP service provider based on Data Envelopment Analysis and Preference Voting is proposed.

Keywords: Internet marketing, Facebook social network, Data Envelopment Analysis (DEA), Performance, Efficiency

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1. Introduction

By entering the age of information and networked society, we are witnessing various technological developments in most fields. Internet as a new media and one of the most important achievements of the communication revolution in this century. Among the new phenomena that formed due to the integration of different communication technologies in recent years are virtual social networks. These networks have been able to play an essential role in various streaming by recruiting users for free [1].

Virtual social networks are a new generation of internet websites, in these websites' internet users gather around a common axis virtually and form online communities. These networks are a new generation of social relations space that, although they do not have a very long life, have been able to make a good place in people's lives [2].

These networks are places to exchange ideas where people share their opinions and opinions and are generally places in the virtual world where people introduce themselves briefly and are the pillars of communication between themselves and their like-minded people in different fields. They provide a favorite. Although various social networks have been established around the world to communicate between people, Facebook as the most popular social network in most countries has been welcomed by the public, especially the young generation [3] and is currently one of the It is the most popular sites in the world that has attracted many people of different ages and walks of life.

This network is a vast and innovative territory that brings new facilities, freedoms, opportunities, harms, and limitations to its residents and is influential in various aspects of people's lives. One of the aspects that is affected by this space is the health of the users in different physical, mental, and especially social areas [4] considering that this space has an undeniable effect on the thoughts, emotions and health of people, especially the young generation. The current research is examined in the form of social health as a dependent variable. Health is an issue in all cultures and its definition in any society goes back to a certain extent to people's common sense of their health and culture. but usually whenever it is mentioned, its physical dimension is considered, while the growth and excellence of the society depends on the well-being of that society from the physical-psychological and social dimensions, not just the absence of disease [5]. Therefore, social health, along with physical and mental health, is one of the three elements that make up the general health of the society. In fact, we consider a person to have social health when he can perform his social activities and roles in a normal way. Feeling connected with society and social norms [6]. Goldsmith defines social health as the evaluation of significant positive and negative behaviors of a person in relation to others and introduces it as one of the most basic health indicators of any society, which will lead to the efficiency of a person in society. Larsen Having correct social thoughts and having a positive mindset towards society is the first and most important stage of social health to have a better social life [7].

As mentioned, currently the young generation and especially students use social networks, especially Facebook, the most [8]. Barat Social networks in virtual space have led to the evolution and intensity of human communication in all parts of the world and have created a qualitative change in the way people communicate with each other, so that by being in virtual space, it is possible to benefit from a multitude of Information has been provided in the shortest possible time and verbal, written and visual communication at a relatively low cost [9].

Communication in the Facebook social network provides users with different conditions from face-to-face relationships. The speed of action, anonymity, etc. provides the same and similar space regardless of requirements such as gender, class, ethnicity, race, and location, which has created different experiences for users. The interactions that take place in this network have created new mindsets and tendencies for people, which can cause changes in their behavior and interactions in the real world, however small [10]. The use of social networks can affect different cultural, personal, social and affect the psychology of people and society. One of these fields that undergo changes and transformations by being in virtual social networks is the social health of users, especially the young generation [11].

Social networking sites, which are virtual communities of Internet users, are among the most news-making websites of recent years on the Internet and contain a significant part of users' activities. The amount of use of the Internet and virtual networks is expanding so much that the current generation is called the Internet generation or the network generation [12]. Social networking sites are web-based that connect people to groups to share information over the Internet. In the last few years, social networks such as Facebook have faced unprecedented global popularity, so that millions of people from all over the world are members of this network, and their human relations, type of cooperation, professional affiliation and many social, cultural, and economic affairs are based on it.

Therefore, in terms of the range of users, it can be said that there is more than a global information space in the space of virtual social networks [13]. In the meantime, Iranian users' acceptance of the mentioned sites has had a significant trend, so that Facebook is known as one of the top ten sites welcomed by Iranians in the web space [8]. The amount of use of these virtual networks will shape changes in different areas of human life such as personal, psychological, social, and moral.

2- Literature review

Social health is "evaluating the conditions of a person and his efficiency in society" which reflects positive social health; It defined [14]. This definition indicates the fact that social health reflects people's understanding of their experiences in the social environment. Keynes listed five criteria of social acceptance, social participation, social adaptation, social flourishing, and social cohesion for social health [14].

Social cohesion is an individual's understanding of the quality of his social world and the way it is organized and functioned Keyes and social flourishing is an assessment of the potential and trajectory of society and includes people's understanding that they too will benefit from social development and that Institutions and people in the society are flourishing in a way that brings the promise of development. In other words, social prosperity is a reflection of the level of people's normal functioning, which is the result of their acceptance of new experiences and continuous growth [15].

Social acceptance is the social version of self-acceptance [16]. The meaning of social acceptance is one's understanding of the society according to the characteristics of other members of the society and includes acceptance of pluralism with others, trust in the inherent goodness of others and a positive view of the nature of humans, all of which make a person feel comfortable with other members of the human society. and relax [14].

In the following, we refer to some research that have examined the influence and role of social networks in other aspects. The

results of Kwat and Kiesler 2002 showed that the positive effect of virtual spaces on increasing social support is due to the imposition of communication with friends or the formation of new relationships. In the research [17], they concluded that virtual networks create a space for social interaction in which there is no need for social skills for interpersonal interactions. Research result [18].

Regarding the effect of various types of internet activities on well-being and social support, it showed that increasing the hours spent working in virtual environments has an inverse relationship with endangering mental health. Lennart 2007, in a study on the reasons for users' tendency to virtual social networks in the United States, found that 91% of users use these sites to maintain relationships with their friends. 82% seek to maintain relationships with those they hang out with, and 72% use these sites to create and follow up on social projects [19].

In research Zahoa 2009 entitled Social Networks, Individual Values, and Creativity, they investigated the influence of social networks among users and the increase in creativity in the use of those tools [20]. The findings showed that there is a linear relationship between the amount, number, and quality of interactive relationships of users and the increase of their creativity and reasoning power, and virtual social networks play a significant role in increasing these interactions. The experience of cybernetic space on social identity at the three levels of family, peer group and society has been investigated by [21].

The results of this research identified a significant relationship between the cybernetic space and each of the three levels of social identity (family identity, peers, and national identity) of the respondents and showed that the use of cyber space did not affect the social identity of the respondents [21].

Dastjardi investigated the role of cyber networks on the cultural identity of Isfahan University students. The results showed that there is a significant relationship between the amount, motivation, and goals of using cyber networks and students' cultural identity, and the most important goals of using cyber networks were social, communication, personal and cultural goals [11]. In research Shahabi investigated virtual social networks and young users, the results showed that the reasons for the presence of young users aged 18 to 30 on Facebook are different and completely personal depending on the social roles of the people [22].

And only in some cases, political implications and consequences can be attributed to the network actions of some young people, and young users are present in virtual social networks in order to continue current friendships, old friendships, dating, finding information, entertainment, recreation, avoiding limitations, entering the modern world. found and feel satisfied and happy with their network interactions.

In research Dastjardi and Abedini they investigated the use and motivation of using virtual social networks and its relationship with students' academic performance. The results showed that there is a significant relationship between the amount and motivation of students using virtual social networks and the academic performance of students. Also, among the applications of using virtual social networks, there is a significant relationship between scientific and research applications, interaction with immigration experts and the feeling of need with students' academic performance [11].

Among the research that have been conducted in recent years focusing on social networks is the study in which the impact of these networks has been investigated in the context of a large university research [23]. Patil, & Atique,

processed and analyzed big data in social networks using Bayes networks. Also, in a review study Ghani, investigated data analysis methods in social networks [24,25].

3-Problem Definition

The public relates to marketing in their lives. Marketing is a process through which people's standard of living is developing. A lot of people think that marketing is the same as selling, but in fact, marketing activity is done before and after the sale. Marketing practically includes many activities (such as marketing research, product development, distribution, pricing, personal selling, etc.) and its purpose is to satisfy the needs of buyers and achieve organizational goals at the same time.

The old definition of bazaar means the place of face-to-face communication between the customer and the seller, and a place where supply and demand meet. In today's world, with the series of developments and developments in it, for buying and selling, there is no need for the physical presence of both parties in a single place. The expansion of transportation and information and communication facilities, such as telephone and postal systems, has created an environment where companies can receive orders from their customers from all over the world and send the desired goods to them.

In the new definitions of economic knowledge, the market includes a set of potential and actual buyers who have come to receive goods, services, or anything else of value. A specific scope for marketing is not specified, and marketing is a general concept that is used in every region. It is carried out geographically, whether in the city, province, country or between countries and at the international level. Of course, at every level, there are certain considerations that overshadow the marketing activity. International marketing activities are more complicated than domestic or regional marketing; And factors such as culture, political environment, economic factors and the level of technology specific to each country and unfamiliarity with the mentioned elements provide the causes of such complications.

Due to these differences between people and countries and cultural issues, the experience of one country can never be used for another country. If the customers, competitors, distribution channels and media available in different countries are different, it is necessary to change the marketing plan and activities according to the conditions. The increasing progress and development of information and communication technology has created deep and extensive effects in business processes.

And the Internet, as the most effective field of electronic marketing with global coverage, has made it possible for companies to reach international markets; However, many companies do not have the necessary information and knowledge in the field of how to use various electronic marketing methods and their effects in export markets.

Commercial foundations are rapidly evolving and settling in new dynamic areas, and therefore the Internet should be considered one of the most extensive media that has created countless changes in the field of marketing and development. These capabilities have affected many areas in marketing, including segmentation and targeting, pricing, customer service and customer relationship management, packaging, marketing communications, promotion, distribution channel. And he mentioned the value chain, global marketing, and trademark.

Placing a product or brand in front of millions of active users in social networks is a marketing strategy in social networks. Social networks provide platforms for companies to post their messages and create buzz about business; and finally achieve faster results in their marketing plan. In addition, this solution increases the quality of incoming website links, increases website traffic, and allows companies to have more control over the process of creating an image of the company's brand.

Social networks generate extremely high traffic. Internet advertising and marketing tools considered as two categories that have undergone changes very quickly with the emergence of social networks. Numerous of discussions about social networks and their influence in marketing. Organizations have created their own pages on Facebook, Twitter, and other virtual social networks. It should be mentioned that while many people believe that the value of word of mouth among customers is very high, the real value of social networks is not yet fully known.

Of course, the experts and activists of this sector still believe that social networks have not necessarily destroyed the previous methods in general, however, they say that the expansion of the penetration rate of these networks may lead to newer methods in this sector in the future.

In this article, focusing on the Facebook social network, we are going to look at a suitable evaluation model based on Data Envelopment Analysis in relation to the way of republishing commercial posts in this network. To validate the considered procedure, in this paper we consider a global cosmetics company with a well-known brand. This review includes five hundred posts published by the company in 2014 on the Facebook social network page. Therefore, this data set of posts is applied as input for Data Envelopment Analysis

3-1. Data Envelopment Analysis based on integer indices

Data Envelopment Analysis is a powerful mathematical method that uses linear programming to determine the relative efficiency of a set of homogeneous decision-making units, or DMUs. A DMU considered efficient when no other DMU can produce a more efficient output using the same or even fewer inputs. Originally, the first known DEA model was presented by Charnes, Cooper and Rhodes under the (CCR) model. DEA makes no assumptions about the internal workings of a DMU. That is, DEA treats each DMU as a "black box" that considers only the input and output consumed by each DMU.

This view is often appropriate and sufficient. For example, if the goal of the analysis is to identify inefficient DMUs and evaluate their inefficiency, then "black box" is an appropriate approach.

Data Envelopment Analysis (DEA) is a mathematical programming approach to investigate the performance of decision-making units (DMUs) covering multiple inputs and outputs. The usual DEA models consider inputs and outputs with real value. However, there are many cases where some inputs or outputs should only take integer values. For example, in evaluating the effectiveness of a company's published posts on the Facebook page, there are discrete inputs and outputs. While rounding performance goals to the nearest correct number does not necessarily make a big difference for large decision-making units, it will be problematic for small decision-making units.

The need to contrast against the data with the correct value in Data Envelopment Analysis naturally occurs when definite and ordinal data are used, but limiting all indicators can be done even when the input and output variables in the scales It is

important whether they are defined as distance or relative

(Lozano and Villa, 2006) were the first to address this issue at a more general level and proposed a mixed-integer linear programming (MILP) DEA model to ensure the need for integer-based computational objectives. In the following Kuosmanen 2009, by removing the weaknesses of the model Lozano 2006, have presented a more complete model for evaluating the performance of decision-making units based on integer indicators, which in this research is used to evaluate the efficiency of shared posts. We use it on the Facebook page of a commercial company. The model presented by Kuosmanen 2009, can be presented in the form of relations [26,27].

$$EFF(x_o, y_o) = \min\ \theta - \varepsilon\left(\sum_{r=1}^{s} s_r^+ + \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{p} s_i^I\right)$$

$$s.t. \qquad (1)$$

$$y_{ro} + s_r^+ = \sum_{j=1}^{n} y_{rj}\lambda_j \qquad r \in O$$

$$\theta x_{io} - s_i^- = \sum_{j=1}^{n} x_{ij}\lambda_j \qquad i \in I^{NI}$$

$$\tilde{x}_i - s_i^- = \sum_{j=1}^{n} x_{ij}\lambda_j \qquad i \in I^{I}$$

$$\theta x_{io} - s_i^I = \tilde{x}_i \qquad i \in I^{I}$$

$$\tilde{x}_i \in \text{int}\,eger \qquad i \in I^{I}$$

$$\lambda_j \geq 0 \qquad j \in J$$

$$s_r^+ \geq 0,\ s_i^- \geq 0,\ s_j^I \geq 0 \qquad r \in O, i \in I,\ j \in I^I$$

The above model is an input-oriented Data Envelopment Analysis model whose return to scale considered constant (CRS). Since in the process of publishing Facebook social network posts, the decision maker can affect the obtained outputs by changing the inputs, therefore, an input-oriented Data Envelopment Analysis model was used in this research.

4-Numerical case

In this article, we use the dataset reported by [28]. This dataset consists of posts published between January 1st and December 13th, 2014, on Facebook pages belonging to a well-known cosmetic brand worldwide. As a result, the dataset contains a total of 500 published posts. It should be noted that Facebook was one of the most popular social networks with an average of 1.28 billion monthly active users in 2014, followed by YouTube with 1 billion and Google+ with 540 million users. The dataset introduced in this research has the following four features:

• Identification: Features that allow each post to identified.

• Content: The textual content of the post.

• Classification: Features that classify the post.

• Performance: criteria for measuring post effects.

In this article, we intend to measure the efficiency of a set of posts in terms of type and group. A "group" is a single column of the database that created by Facebook page administrators. This classification is a request from the chief marketing officer of the companies, which depends on the type of campaigns implemented by a particular cosmetic health company. It provides a reach classification by campaign for items related to post content. To minimize the risk of misclassification due to typing errors for manual procedures, professionals try another item on the company's social media that checks the category for all 500 posts.

The characteristic of the type of posts in the database refers to the way of uploading posts on the Facebook page, which can be in four forms: link, photo, report and video. The grouping of the posts implies the triple specification of content under the title of action (competitions and special offers), product (direct advertising, explicit brand content) and inspiration (brand content). But based on the information in the database, generally

based on these two variables, there are 10 alternatives for posts, which are:

1) Link post type and post group 1
2) Link post type and post group 2
3) Link post type and post group 3
4) Photo post type and post group 1
5) Photo post type and post group 2
6) Photo post type and post group 3
7) Photo report type and post group 1
8) Photo report type and post group 2
9) Photo report type and post group 3
10) Type of video report and post group 1

As you can see, the company has used the type of video posts only for group 1 posts, and groups 2 and 3 do not have video posts.

The collected performance measures determine the performance of posts in several aspects. Some are derived directly from engagement with posts, such as the number of comments, likes, and times a post is shared. "Total Page Likes" measures the number of pages' likes at the time the post is published. The remaining metrics are not so intuitive. In general, a conceptual map can be shown to understand the concepts that exist in each performance measure.

These concepts can divide into visualization and interaction. "Impressions", so-called "impressions", are based on counting the number of times a post is loaded in a user's browser, either directly or through another user's interaction. "Interactions" are considered for each type and source of post clicks, engagement is a more robust metric such as user feedback from the post, since loading content on a browser truly means that a post has attracted a user's attention. is not. At the same time, each concept is used for visualization or interaction. Facebook also creates and considers criteria for each user that each user may see and react to a post more than once. Each of these features can be the output of a post. It should be emphasized that the "Total Page Likes" attribute does not apply to every post, but instead is important to the page's performance. Hence, its consideration may affect the publication effect of each post, so we considered it as an input feature. Table 1 shows the outputs of Data Envelopment Analysis model. The remaining two features are detected before the post is published and can be used as input. Table 2 provides a description of these entries

Table 1: Description of data coverage analysis outputs

Variable	Description
Y_1	The total number of comments in the post collection
Y_2	The total number of likes in the post collection
Y_3	Total number of shares in the post collection

Table 2: Description of data envelopment analysis inputs

Variable	Description
x_1	Total page likes
x_2	Number of posts placed from each type-group combination

5. Results

In this part, first, in Table 3, the values of each of the input and output indicators for the ten alternatives presented. Next, the number of people who have liked the company page for each type of content and in each group, the number of posts for each type of content and in each group, and the total number of comments, likes and shares in the post collection for Each type

of content and in each group is shown schematically in Figures 1 to 5, respectively.

At this stage, using the inputs and outputs shown in Table 3, the CRS and input-oriented Data Envelopment Analysis model solved based on discrete data. In this research, Lingo software used to solve this model. The results can see in Table 4. Next, in Figure 6, the effectiveness of each of the posted content-groups shown in the form of a bar chart.

As it is clear from the results, the effectiveness of the five content-groups posted on the company's Facebook page are categorized as effective content-groups, and the other five alternatives are considered ineffective content-groups. Analyzing the efficiency of different alternatives in various fields using Data Envelopment Analysis has the advantage that specific work patterns can be introduced for inefficient units. For example, according to the information in Table 4, the posts published on the company's page are shared as links and they are in the group of the first posts, they are identified under the title of ineffective content group. For this alternative, the fifth, sixth and tenth content groups are identified as effective patterns. In the same way, for the 7th non-functional content group, the 6th and 10th functional content groups have been selected.

Table 3: The values of each of the input and output indicators for ten alternatives

Y_3	Y_2	Y_1	x_2	x_1	**Alternative**
254	1513	58	2359683	20	Link post type and post group 1
15	32	2	98195	1	Link post type and post group 2
15	68	2	102111	1	Link post type and post group 3
3300	23212	1091	22783724	185	Photo post type and post group 1
3231	21463	1064	11566097	91	Photo post type and post group 2
4979	32963	1037	17773056	150	Photo post type and post group 3
81	409	13	358835	3	Photo report type and post group 1
1220	6937	377	5060762	38	Photo report type and post group 2
113	606	11	549497	4	Photo report type and post group 3
365	1620	86	945104	7	Type of video report and post group 1

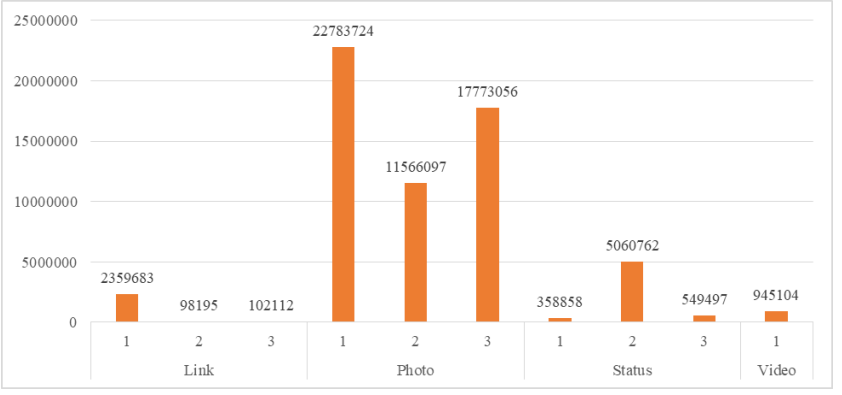

Figure 1: The number of people who liked the company page for each type of content and in each group

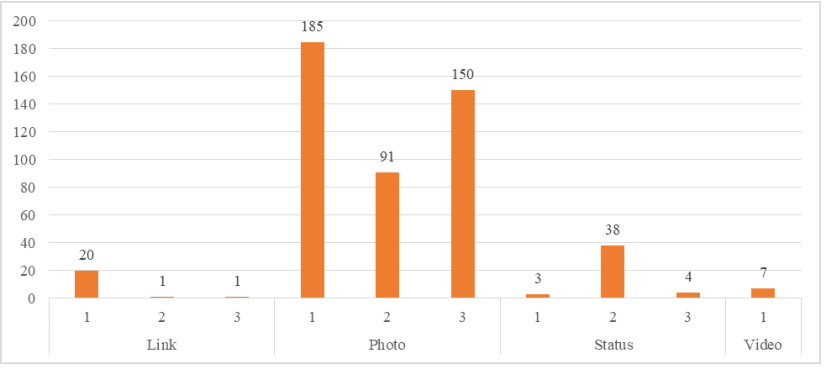

Figure 2: Number of posts for each content type and in each group

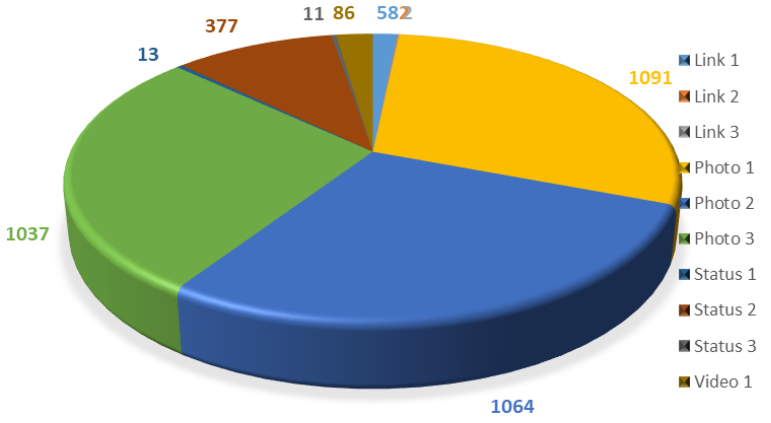

Figure 3: The total number of comments in the post collection for each type of content and in each group

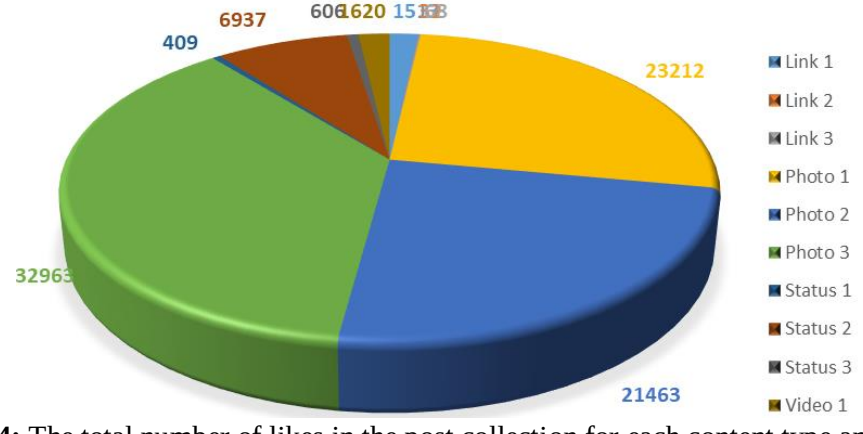

Figure 4: The total number of likes in the post collection for each content type and in each group

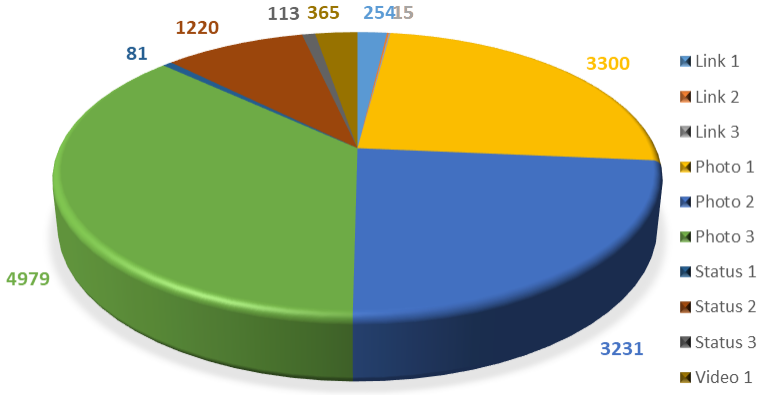

Figure 5: Total number of shares in the post collection for each content type and in each group

Table 4: Results obtained from the solution of CRS and input-oriented Data Envelopment Analysis model, based on discrete data.

λ_{10}	λ_9	λ_8	λ_7	λ_6	λ_5	λ_4	λ_3	λ_2	λ_1	θ	**Alternative**	
0.2123	0	0	0	0.0305	0.0076	0	0	0	0	0.3521	Link post type and post group 1	1
0	0	0	0	0	0	0	0	1	0	1	Link post type and post group 2	2
0	0	0	0	0	0	0	1	0	0	1	Link post type and post group 3	3
0	0	0	0	0	1.0814	0	0	0	0	0.5490	Photo post type and post group 1	4
0	0	0	0	0	1	0	0	0	0	1	Photo post type and post group 2	5
0	0	0	0	1	0	0	0	0	0	1	Photo post type and post group 3	6
0.1597	0	0	0	0.0045	0	0	0	0	0	0.6666	Photo report type and post group 1	7
3.5	0	0	0	0	0.0714	0	0	0	0	0.8168	Photo report type and post group 2	8
0.1797	0	0	0	0	0.0146	0	0	0	0	0.75	Photo report type and post group 3	9
1	0	0	0	0	0	0	0	0	0	1	Type of video report and post group 1	10

6- Conclusion

Today, the Internet has brought significant fundamental changes in how many things are done. The Internet has increased the speed of all processes and has broken geographical boundaries, and especially in consumer expectations (which plays a major role in retail sales), it has created changes. Basically, the costs of searching for information through the Internet have reached almost zero, and therefore, if we want to sell ordinary things, it is the buyer who will always win.

In other words, the seller parties are facing tough competitors in terms of price, quality and service, because the entry barriers for electronic business are relatively low and customers can get what they want based on easy access to Obtain information through comparison.

Meanwhile, social networking sites, which are virtual communities of Internet users, are considered the most news-making sites on the Internet in recent years. Based on a study conducted by Anderson Analytics on users of virtual social networks, including Facebook, it has discussed the difference in the use of virtual social networks by generations and age groups.

The World War II generation is the oldest group that uses social networks. This generation is those who have experienced the Second World War in their lives and are now spending their old years. This generation uses Facebook the most and LinkedIn the least when it comes to using social networks. This generation is significantly different from other generations in the reasons for using social networks.

Based on this, it can be concluded that social networks like Facebook are very important for internet marketing and introducing products to customers. In this research, we have been looking for an efficient method to identify the effectiveness of posts published for advertising purposes by commercial companies. Therefore, by using an input-oriented Data Envelopment Analysis model, where the return to scale is considered constant (CRS), we calculated the efficiency of Facebook social network posts of a commercial company. This research can be implemented if the information related to the advertising posts of Iranian companies is available on the pages of these companies in other social networks.

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