Applying Golden Ratio in Product Packaging and Its Effect on Consumer's Buying Behaviour

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Packaging is one of the most effective marketing tools in sales of most products especially consumer products. Due to the fact that most purchases particularly in department and chain stores are performed randomly and without a previous plan packaging plays a key role in attracting buyers' attention. Different factors like color, shape and structure are involved in packaging attractiveness. Another important factor is the application of golden ratio (1.618). This paper aims at investigating the effect of golden ratio application on packaging attractiveness and buyers' attention. For this purpose a group of packages were modeled with golden ratio using linear programming and were placed next to packages without golden ratio. Then the views of 400 consumers from Tehran were investigated. Findings analysis supported the hypothesis that packages with golden ratio are more attractive than other packages. Also it is suggested that gender and age has no effect on the selection of packages with golden ratio.

JEL Code: M31

1. Introduction

Numerous market trends suggest a growing role for product packaging as a brand communication vehicle. Marketing depends heavily on the visual communications of packaging to inform and persuade consumers both at the point of purchase and at the point of consumption (Underwood, et al, 2001). It is suggested that packaging may be the biggest medium of communication (Behaeghel, 1991; Peters, 1994). Three reasons are given for this:
(1) Its extensive reach to nearly all purchasers of the category;
(2) Its presence at the crucial moment when the purchase decision is made; and
(3) The high level of involvement for users who will actively scan packaging for information.

On the other hand, with the advent of self-service selling (which is mainly due to increase in large department and chain stores) the package assumed the role of "silent salesman" (Kornblau, 1961) using visual communications to get the consumer's attention, introduce its contents, and encourage the consumer to make the purchase (Mc Neal and Ji, 2003). Based on a research by Henley Centre, 73 percent of purchase decisions are made at the point-of-purchase (Rettie and Brewer, 2000;Ampuero and Vila, 2006).Phillips and Bradshaw showed that unplanned purchase of grocery items includes more than 51 percent of purchases (Nancarrow et al., 1998; Ampuero and Vila, 2006).

The concept of package design is inherently multidimensional incorporating multiple elements such as text, shape, graphic design, logo, size, colours, illustrations, material,

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construction, texture, etc(Underwood, et al , 2001) and the review of the marketing literature revealed that researchers have focused on different dimensions of package design. Early packaging research focused on the general characteristics and role of package design (cheskin,1971; Faison, 1961; Schucker, 1959; Schwartz, 1971), including packaging as a means of communication (Gardner, 1967, Lincoln,1965) and as variable influencing product evaluation (Banks, 1950; Brown, 1958; McDaniel and Baker, 1977;Miaoulis and d'Amato, 1978). Additional research integrated packaging with other extrinsic cues (e.g. price, brand name) to examine the influence on product quality perceptions (Bonner and Nelson, 1985;Rigaux-Bricmont, 1982;Stokes, 1985).Other packaging-related research includes studies examining the veracity and communicative competence of packaging (Polonsky et al., 1998, Underwood and Ozanne 1998); ethical packaging issues (Bone and Corey 1992, 2000), and research measuring the impact of package size on consumer usage (Wansink, 1996). Despite widely reported researches regarding packaging there are few studies focusing on the emotional and mental aspect of packaging and its effects on consumers buying behavior.

In recent decade studies focusing on the visual impact of package on consumer attention includes: categorization and evaluation (Plasschaert, 1995; Schoorsman et al., 1997); Pieters and Warlop's (1999) examination of visual attention during brand choice; Rettie and Brewer's(2000) study on the verbal and visual components of package design, Murray and Delahunty's (2000) examination of consumer preference mapping for the sensory and packaging attributes; Yang and Raghubir's (2005) work on the effect of package shape on how much to buy; McNeal and Ji's (2003) study on children's visual memory of packaging and the evaluation of the experiential levels of consumer packaged goods by Serrano et al,(2011).

Despite growing evidence of package size and shape affecting volume perceptions and consumption level, analysing the effect of package size on attracting consumer's attention and the way it influences buying behaviour at the point of purchase is a relatively new area of inquiry. According to Wang and Chou(2007) product packaging is the most immediate stimulation that consumers come across and the level of attention they pay to those packages are possibly different. Given that designers formulate product packaging by using various elements, investigation presented in this study examines whether the packaging size as a criterion is effective in attracting buyers' attention and in order to explore this, the golden ratio is applied as a determinant in packaging size.

In view of exploring how golden ratio can affect consumer's attention, this research looked into related literature on golden ratio and its impact on perception in the literature review, in the methodology section the procedure followed for modelling packages with golden ratio, sampling process and hypotheses development are explained, findings from those literature and modelling procedure were then further analysed in results and analysis section. Based on the research findings and given that no research is conducted regarding the application of golden ratio in product packaging the reported results of the following study are relatively new from marketing perspective.

2. Literature Review

The golden ratio and its impact on perception.The Nature follows certain tendencies and rules in designing its parts based on a number equal to 1.618, the (ϕ) number. This ratio exists in many parts of the nature from sunflower to the human body structure and called

golden ratio which is considered as the brand name of the nature. The golden ratio is also known as Fibonacci number, Phidias mean, golden mean, golden section, golden cutting, sacred size, golden number and infinite ratio (Dunlap, 1997).

Consider a line consisting of two parts "a" & "b. Part "a" is larger than part "b". There will be a golden ratio between these two parts if the ratio of (a) to (b) is equivalent to the ratio of line (a+b) to (a):
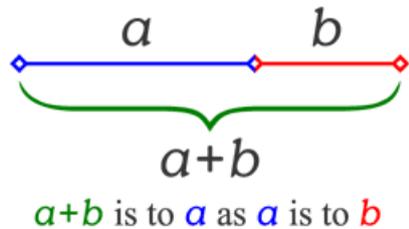
$$\frac{a+b}{a} = \frac{a}{b} \Rightarrow a^2 = ab + b^2$$

$a+b$ is to a as a is to b

To solve this simple equation, $a^2=ab+b^2$, (put a number like 10 for "b", then "a" is attained) a ratio equals to 1.618 is obtained. A given rectangle drawn by this line will be called golden rectangle if the ratio of its length to its width is 1.618. This rectangle is aesthetically the most pleasant one (Dunlap, 1997).In other words, the rectangles with golden dimensions are more aesthetic and attractive compared to other ones. Literature in art, architecture, music, history and even biology has laid an emphasis on the mathematical beauty of certain shapes (Ghyka, 1997). The role of golden ratio in art (The Vitruvian Man), architecture (the Pyramids of Giza and the Parthenon in Rome), and the religion (Christian Cross) etc have been dealt with extensively in research (Thiyagarajan, 2006).

Figure 1: Golden ratio in art and architecture
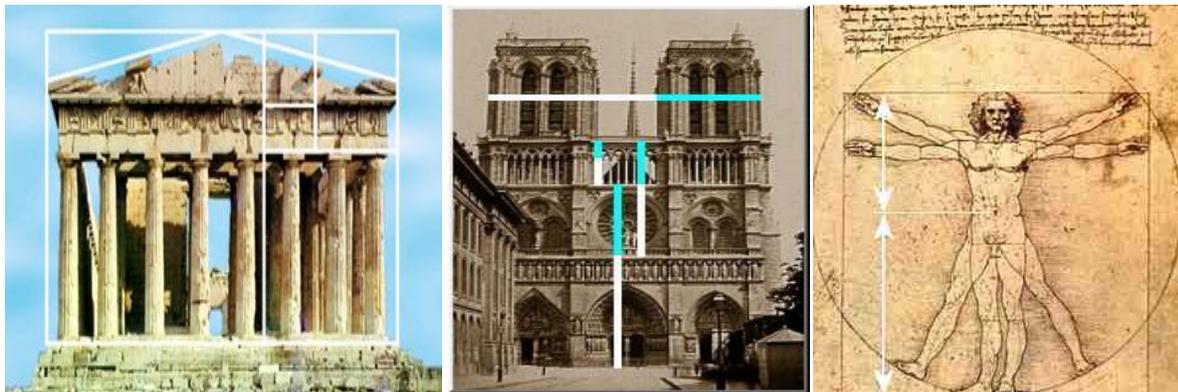
The golden mean, ϕ, has been applied in diverse situations in art, architecture, and music,and although some have claimed that it represent a basic aesthetic proportion, others have argued that it is only one of a large number of ratios (Raghavan, 2010).According to Raghavan, studies conducted in the American context have shown the influence of rectangle's shape, determined by its side ratio, on preference and purchase intentions. In a study conducted by Pittard, Ewing and Jevons (2007), the reactions towards rectangular proportions across different continents were examined and it is concluded that there is a universal preference for the golden ratio across different cultures. Raghubir and Greenleaf (2006) conducted an experimental study to examine the impact of the ratios of the sides of the rectangles on the purchase intention of

consumers for rectangular products. They used a square and two rectangles with differing ratios (1.38 and 1.62) with description of two concerts (A and B) to manipulate the ratio variable. Their study showed the significance of the rectangle's ratios in determining differences in purchase intention, preference and relative preference.

Although a number of studies have shown the connection between the product package design and shape with consumer's perception and buying behaviour, an overview of the research background indicates that little research is conducted on the application of golden ratio, as a determinant of package size, on buying decision.

3. Methodology

3.1. Non-linear Programming

To answer the research question and collect required data, golden packages were designed using non-linear programming model and put besides other packages and then interviews' opinions were investigated. In order to model a package which simultaneously has two sides with golden ratio, contain certain volume of product and also least amount of raw materials to be used in its production, non-linear programming is used as in most real situations, models follow non-linear algorithms (boroomand,1999).To model packages, tea packs with the net weight of 100 and 500 grams were selected, finally three considerations were made in designing these packages based on non-linear programming: (1) the packages contain certain volume of tea, (2) have two dimensions with golden ratio and (3) the minimum raw materials to be used in their production.

In order to better understand the dimensions and also limitations related to non-linear programming an opened package has been shown in figure2.

Figure 2: An opened package with its dimensions
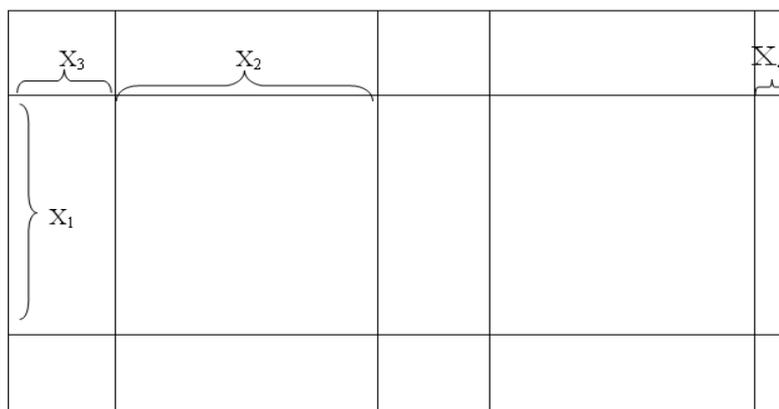
X_1: length, X_2: width, X_3: depth or height and X_4: paper amount or the materials embedded or stuck into other parts.

Objective function: To minimize necessary materials used in packaging (such as paper), area should be minimized. Area is calculated as:

Area= Length ×Width

According to figure….the length and width are as following:

Length= X_1+2X_3

Width=$2X_3+X_4+2X_2$

Then, the area is:

Area=$(2X3+X4+2X2) \times (X1+2X3)$

And finally, objective function will be written as:

Min Z= $(2X_3+X_4+2X_2) \times (X_1+2X_3)$

Limitations: To design a package whose capacity equals to 100 and 500 grams of tea, the volume of rectangle should be counted. Then primary limitation will be written as following:

$X_1 \times X_2 \times X_3 >= 500$

Now, there is a problem; one side of equation is volume and the other side is weight. To solve this problem, we should multiply volume side by density in order to have weight as criterion of measurement in both sides.

Density= Weight/Volume

There are different volumes for tea and its density cannot be easily estimated; therefore, 22 samples of tea packs were collected and after estimating the mean of their volumes, the density of tea was estimated which equals to 0.3. Then, the first limitation is as follows:

$0.30 (X_1 \times X_2 \times X_3) \geq 500$

$0.30 (X_1 \times X_2 \times X_3) \geq 100$

It is worth mentioning that if the volume of the product is clear (such as a fragment of computer device), there will be no need to multiply density by volume, as a result the above-mentioned limitation is as follows:

$(X_1 \times X_2 \times X_3) \geq$ The volume of the product in question

For cube No.1:

Min= $(2X_2+2X_3+x_4) \times (2X_3+X_1)$

s.t:

$0.30 \times (X_1 \times X_2 \times X_3) \geq 100$ or 500

$$\frac{x_1}{x_2} = 1.618$$

$$\frac{x_2}{x_3} = 1.618$$

$X_4=1$

$X_1, X2, X3, X4 \geq 0$

Using LINGO software, the results of the 100 grams packs will be as following:

$Z=463.815 \quad X_1=11.21 \quad X_2=6.93 \quad X_3=4.28 \quad X_4=1$

For cube No.2:

$Min=(2X_2+2X_3+x_4) \times (2X_3+X_1)$

s.t:

$0.30 \times (X_1 \times X_2 \times X_3) \geq 100$ or 500

$$\frac{x_1}{x_2}=1.618$$

$$\frac{x_1}{x_3}=1.618$$

$X_4=1$

$X_1, X_2, X_3, X_4 \geq 0$

Using LINGO software, the results of packages which weigh 500 grams will be as following:

$Z=1329.65 X_1=19.16 \quad X_2=11.84 \quad X_3= 7.32 \quad X_4=1$

Finally based on the above modeling two packages were designed with golden ratio and put next to other packages with different dimensions. It is worth mentioning that white is the base color in designing these packages. Also, there are no pictures and writings to affect people's selection. The packages have been set in such a way that their difference can be felt. Assuming that all product variables are the same, interviewees were asked to tell which package is more attractive and to prioritize them according to their attractiveness. Even subjects were not told that the package is related to a certain product, because their image about packaging of that product could have impact on their selection.

3.2 Sampling

In order to collect the required data, a sample of 400 customers of Refah chain stores in Tehran were chosen and interviewed. Refahchian store is the first self-service store established in Iran in 1996 with 135 branches throughout the country providing different consumer brands to its customers. As it is stated earlier with the advent of self-service selling due to expansion of chain stores, and unlike the traditional distribution channels, the role of package design in consumer's attraction is being very important; consequently Refah chain store was chosen as a pilot to conduct the interview. As collected data in this study are nominal scale and the number of Refah store visitors is not available a sample of 400 people acquired for data collection using the following estimation:

$$N = \frac{(Z_{\alpha/2})^2 \times P(1-P)}{\varepsilon^2}$$

Where

P: represents percentage of success at subject of study,

α: represents error level of sample volume,

ε: represents precision of estimation.

In this study, we have, P=0.5, ε=%5, α=0.05

There are 15 Refah stores in Tehran. Five of them were selected randomly and in every store 80 subjects were interviewed likewise. The minimum required sample has been estimated as 384 and in this study, 400 subjects were interviewed using the cluster sampling method.

Two series of packages were designed and put into store shelves, 6 packages of 100 grams and 7 packages of 500 grams, among each of these groups, two packages designed with golden ratio dimensions, then the interviewees were asked to prioritize the packages according to their attractiveness assuming that other variables such as quality and ingredient are the same.

3.3 Hypotheses Development

For evaluating the interview results 3 hypotheses were formed and tested:
1-The packaging with golden ratio is more attractive from consumers′viewpoint.
2-There is a relationship between gender and the selection of packages with golden ratio.
3- There is a relationship between age and selection of packages with golden ratio.

4. Results and Analysis

4.1 Hypotheses Analysis

For testing the first hypothesis success ratio test is utilizedat 0.5 significance level for 100grams and 500 grams packages separately. Also a separate test is used for two groups of package simultaneously. Given that from among these packages two of them have dimensions with golden ratio, if interviewees select one golden package in their first two choices, then the code 1 is recorded for their selection, otherwise the code 0 is recorded. As illustrated in tables 1 And 2, 73 percent of the interviewees selected one golden package in their first two choices for 100 grams packages and this is 62 percent for 500 grams packages as well, rejecting the null hypothesis that less than 50 percent select golden package.

Table 1: SPSS output for 100 grams package

Golden package	Abundance No	Frequency%	p-value
(Selected)	291	73%	0.000
(Not-selected)	109	27%	
Total	400	100%	

Table 2: SPSS output for 500 grams package

Golden package	Abundance No	Frequency%	p-value
(Selected)	247	62%	./000
(Not-selected)	153	38%	
Total	400	100%	

Also according to table 3, 56 percent of interviewees selected golden packages in their first two choices for 500 and 100 grams packages simultaneously. These results suggest that packages with golden ratio are more attractive than others from customers view.

Table 3: SPSS output for golden packages (100 & 500 grs)

Golden package	Abundance No	Frequency%	p-value
(Selected)	222	56%	0.031
(Not-selected)	178	44%	
Total	400	100%	

In order to identify the relationship between variables such as gender, age and the selection of golden packages a series of chi square tests is utilized at 0.5 significance level separately for 100 and 500 grams packages. Also a separate test is used for two groups of packages simultaneously. According to tables 4, 5 and 6 more than 50 percent of male and female interviewees selected one golden package in their first two choices suggesting that there is no relationship between gender and selection of golden packages.

Table 4: Relationship between gender and selecting golden packages (100grs)

Gender	Golden pack (selected)	Golden pack (not-selected)	Total	p-value
Male	169, (73%)	63, (27%)	232	0.96
female	122, (72%)	46, (28%)	168	
Total	291	109	400	

Table 5: Relationship between gender and selecting golden packages (500grs)

Gender	Golden pack (selected)	Golden pack (not-selected)	Total	p-value
Male	138, (59%)	94, (27%)	232	0.273
female	109, (65%)	59, (28%)	168	
Total	247	153	400	

Table 6: Relationship Between Gender and Selecting Golden Packages (500 &100 Grs)

Gender	Golden pack (selected)	Golden pack (not-selected)	Total	p-value
Male	123, (53%)	109,(47%)	232	0.24
female	99, (69%)	69,(41%)	168	
Total	222	178	400	

Also regarding the age and its relationship to selection of golden packages the interviewees were categorized into 5 groups as illustrated in table 7. As it is shown in the table in all of the groups more than 50 percent selected golden packages suggesting that there is no relationship between age and selection of golden packages.

Table 7: Relationship between Age and Selecting Golden Packages (500&100grs)

Age	Golden pack (Selected)	Golden pack (not-selected)	Total	p-value
...<19	43, (51%)	41, (49%)	84	0.61
20<…<29	63, (55%)	51, (45%)	114	
30<…<39	59, (62%)	36, (38%)	95	
40<…<49	33, (55%)	27, (45%)	60	
50<…	24, (51%)	23, (49%)	47	
Total	222	178	400	

5. Conclusion

With the increasing popularity of department and chain stores around the world the consumers buying behavior has changed and most of the buying decisions are made in an un-planned manner and at the point of purchase. Given the increasing competitive pressures and the presence of different brands in large stores, firms use different marketing tools such as promotion, high quality production and packaging, etc to attract customers attention. This study investigates whether the packaging size as one of the marketing related variables can affect the consumers buying decision and attract their attention at the point of purchase. To answer this question golden ratio existing in many natural phenomena   is used as a determinant factor in packaging size. Based on the findings it is suggested that the application of golden ratio increases the attractiveness of packaging and attracts customer's attention. Also findings analysis indicated that there is no significant relationship between variables such as age and gender and the selection of packages with golden ratio.

Although the procedure and method used in this research can be used as a reference for package designers, there are a few limitations stated here as reference for future researches: (a) Golden ratio is only one of the effective factors related to product packaging; there are also other factors such as color, volume, shape and design of packages which are effective in consumers' attraction and their buying decision. (b) The role of packaging in sales of products is mostly related to non-programmed and self-service purchases happening in department and chain stores, so the results of this study are widely applied to decisions made in such places. (c) This research identified that application of golden ratio is effective in attracting consumer's attention; however it failed to further investigate the effect of golden ratio in design of packages across different category of products or in different cultures. The results and implications of this research are limited to early 2011.

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