Analysis of Product Package Design Elements through Machine Learning

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▪ *Research Objective:*

We systematically and quantitatively analyze "**elements**" that are used in front package design, and identify "**typologies**"

that are used in **managerial practices**.

Features

Product Name
☐ Logo
Flavor
Brands
Manufacturers
☐ Product Pictures
Ingredient Pictures
☐ Characters
☐ Certification Labels
Health Claim
☐ Size Mention
Colors
Sizes of the elements
Locations of the elements

Texts & Images

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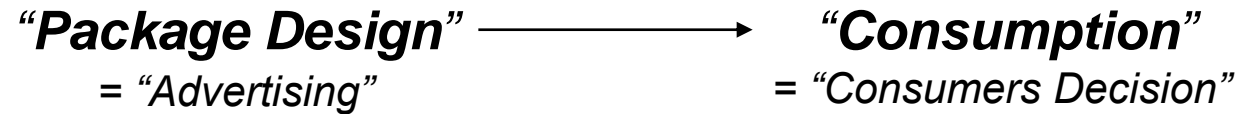that are used in **managerial practices**.

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- Brands
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Texts & Images

Package Design

"Package Design" ⟶ **"Consumption"**
= *"Advertising"*   = *"Consumers Decision"*

Why Important

- **Biggest medium** of communication (Behaeghel, 1991; Peters, 1994).
- Significant in customer's **decision making.**
- **Differentiate** the product from competitors.
- Reinforces a **brand and product positioning**.

Previous Literature

- Previous literature focused on individual elements in package design, mainly through experiments.
- Most research lack a holistic view in package design.
- Position (Barbosa et al, 2012), Color (Huang, L., & Lu, J., 2015), Health Claims (Andre et al, 2019), Nutrition Label (Lim et al, 2020), Health Warnings (McNeill, A. et al, 2017), Holistic Package (Orth, U. R., & Malkewitz, K., 2008)

Data and Pre-Processing

- Walmart – Cold Cereal
- Collected all images
- Perspective Transformation
- Removing irrelevant images
- 418 Images were used for analysis

Perspective Transformation

Feature Extraction

Image Processing
- Labelimg (Annotation Tool)
  - *Size, Location*
- Image *Color* Identification
  with Machine Learning
 - k-means clustering

K-means Clustering

- **Elements**
  - Three Main Colors of an Image
    (Proportion)
  - Size (Ratio and Sum)

- **Identify typologies in package design
  depending on:**
  - Brands
  - Groups
  - Positioning

Package Elements

Category	Elements	Features	Literature
Text	▪ Product Name ▪ Brand ▪ Size Mention ▪ Claims (Health / Taste) ▪ Other Texts ▪ Flavor	▪ Texts ▪ Size ▪ Location	Sundar, A., & Noseworthy, T. J. (2014), Klink, R. R. (2003). Laforet, S. (2011) Krishna, A., Cian, L., & Aydınoğlu, N. Z. (2017). Andre, Chandon, and Haws (2019), Chandon, P., & Wansink, B. (2012). Elder, R. S., & Krishna, A. (2010), Cian, L., Krishna, A., & Schwarz, N. (2015) Garber Jr, L. L., Hyatt, E. M., & Starr Jr, R. G. (2000).
Image	▪ Colors ▪ Logo ▪ Product Picture ▪ Character ▪ Ingredient Picture ▪ Certification Labels	▪ RGB & HSL ▪ Size ▪ Location	Spence, C., & Velasco, C. (2018), Garber, L. L., Burke, R. R., & Jones, J. M. (2000). , Gorn, G. J.,Chattopadhyay, A., Yi, T., & Dahl, D. W. (1997), Mead, J. A., & Richerson, R. (2018) Klink, R. R. (2003). Sundar, A; Noseworthy, TJ (2014), Barbosa, A. A. L., de Moura, J. A., & de Medeiros, D. D. (2021). Underwood, R. L., & Klein, N. M. (2002), Deng, X., & Kahn, B. E. (2009)., Barbosa, A. A. L., de Moura, J. A., & de Medeiros, D. D. (2021), Togawa, T., Park, J., Ishii, H., & Deng, X. (2019)., Underwood, R. L., & Klein, N. M. (2002) Hebden, L., King, L., Kelly, B., Chapman, K., & Innes-Hughes, C. (2011), Chacon, V., Letona, P., & Barnoya, J. (2013) Thomas, F., & Capelli, S. (2018), Capelli, S., & Thomas, F. (2021) Piqueras-Fiszman, B., & Spence, C. (2015), Lim et al (2020), Ikonen, I., Sotgiu, F., Aydinli, A., & Verlegh, P. W. (2020), Buttriss, J. L. (2018)

Preliminary Results (K-means Clustering)
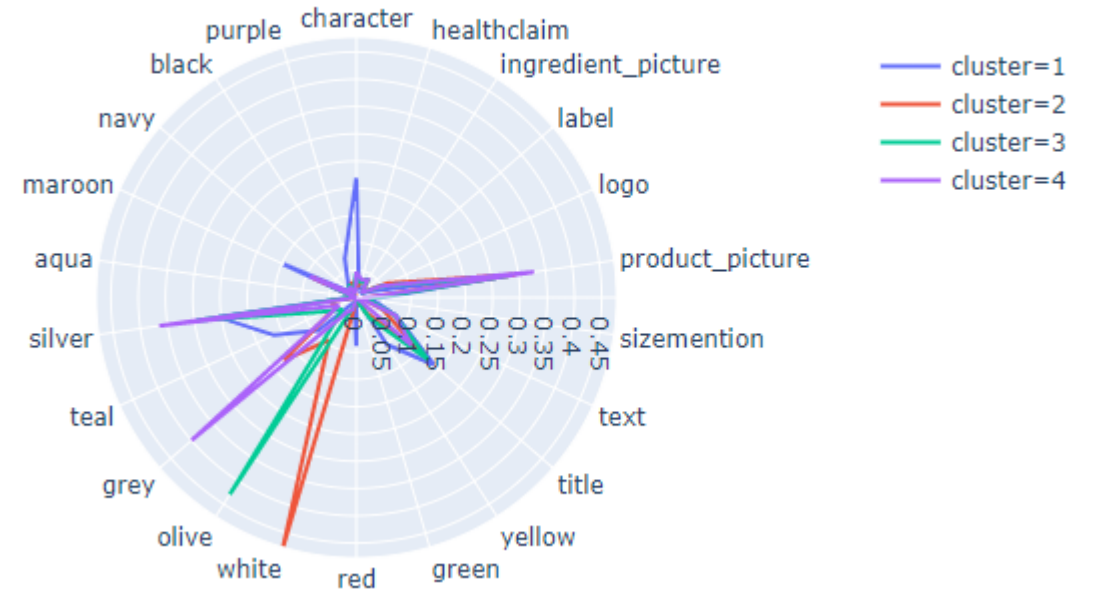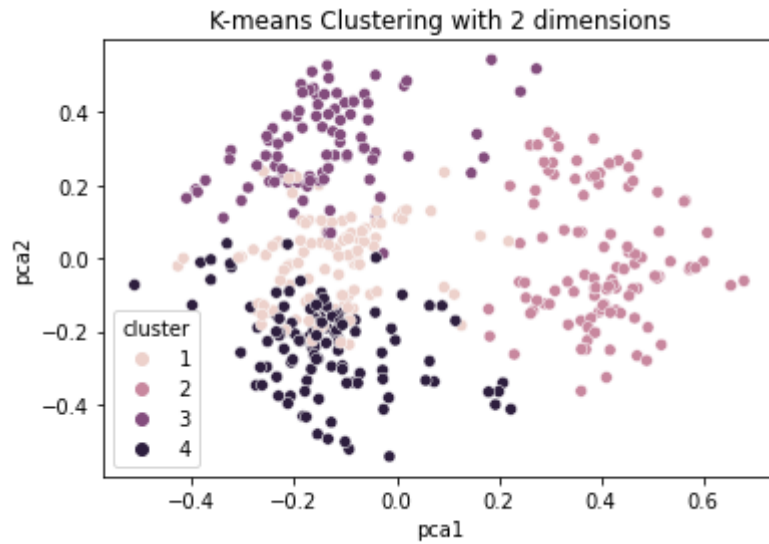
Preliminary Results

Cluster 1 (N=105)
"Kids Appeal"

Characteristics

Brands:
Cheerios, Cap'n Crunch, Lucky Charms, Funko, Oreo o's, Froot Loops, Monsters, Pebbles, Cocoa Puffs …

Colors:
Maroon, Navy, Purple, Red, Teal, Yellow

Major Features:
Character, Size Mention, Texts, Product Name

Cluster 2 (N=107)
"Healthy"

Characteristics

Brands:
Kashi, Special k, Cascadian Farm Organic, Cinnamon Toast Crunch, Great Value, Nature's Path, Life Cereal …

Colors:
White

Major Features:
Certification Labels, Logo

Cluster 3 (N=91)
"Classics"

Characteristics

Brands:
Reese's Puffs, Chex, Nature's Path, Cheerios, Frosted Mini-Wheats, Honey Bunches Of Oats, Envirokidz…

Colors:
Aqua, Black, Green, Olive

Major Features:
Ingredient Picture

Cluster 4 (N=115)
"Niche"

Characteristics

Brands:
Nature's Path, Barbara's, Cheerios, Ezekiel, Great Value, Chex, Special k, BariatricPal, Arrowhead Mills …

Colors:
Grey, Silver

Major Features:
Health Claim, Product Picture

Conclusion

Implication

▪ *Theoretical Implication*

- There is very few research examining package design elements holistically, and even these research are based on human judgement and lack systematic analysis of the elements.
- Using image analysis tools, we analyze how different package elements are used, and identify different typologies used in package design.

▪ *Managerial Implication*

- Provide insight on how different kinds of package elements construct brand positioning.
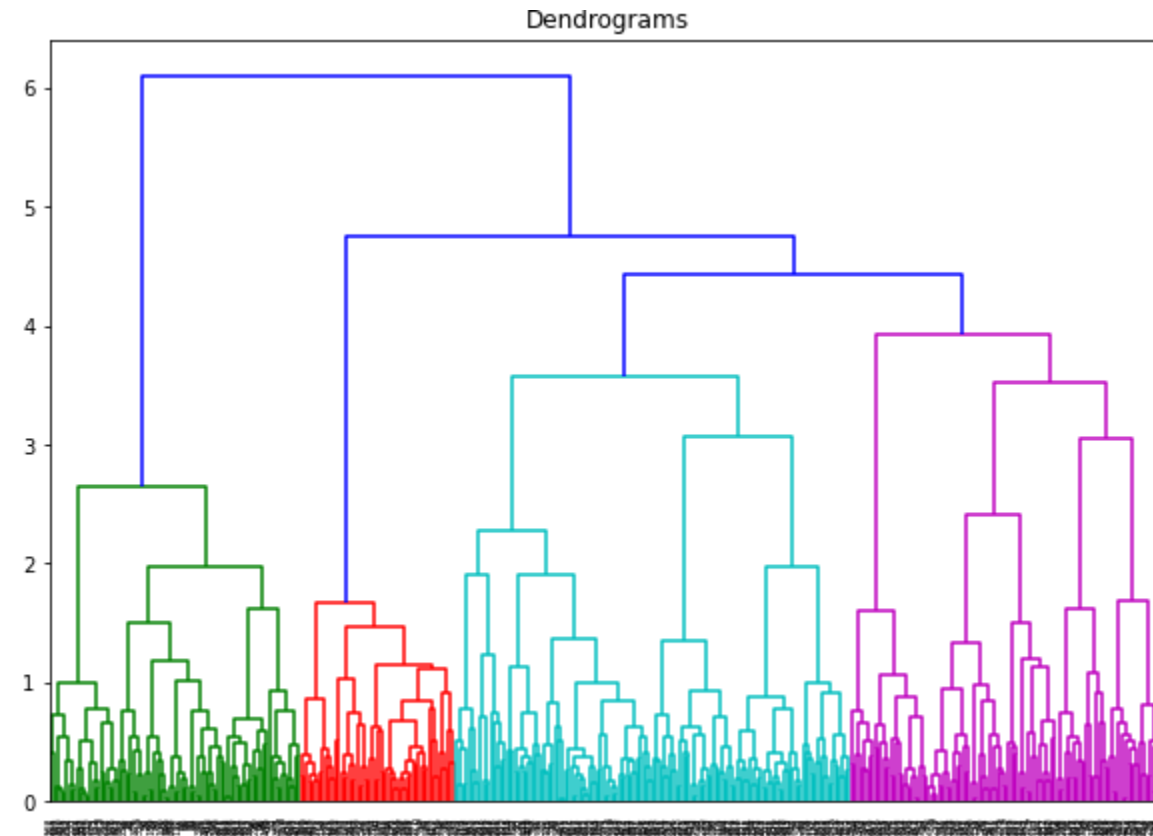- Suggest how managers should utilize the package elements.

Future Research

- Use more sophisticated model for clustering.
- Identify what messages are described verbally vs. via images.
- "How should we change the package design to achieve an alternative brand position?": apply a *Generative Model.*
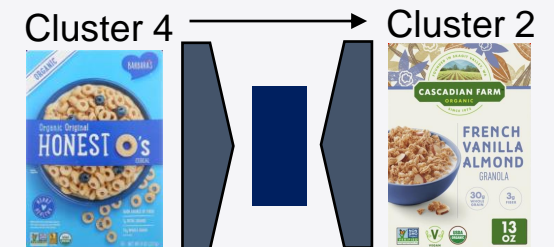
Cluster 4 ⟶ Cluster 2

Thank You

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Dendrograms

Preliminary Results (K-means Clustering)

Brands

Cluster 1	
cheerios	9
cap n crunch	8
lucky charms	7
kellogg's frosted flakes	7
funko	6
rice krispies	5
oreo o's	4
kellogg's raisin bran	4
pebbles	4
froot loops	3
kellogg's raisin bran crunch	3
frosted mini-wheats	3
trix	3
krave	3
cocoa puffs	3
eggo	2
kashi	2
corn pops	2
ezekiel	2
monsters	2

Cluster 2	
kashi	21
special k	17
cascadian farm organic	9
cinnamon toast crunch	7
great value	7
nature's path	6
life cereal	5
one degree organic foods	4
great grains	3
envirokidz	3
kellogg's corn flakes	3
cheerios	2
oatmeal squares	2
all-bran	2
arrowhead mills	2
mccann's	2
total	1
Qi'a	1
happy belly	1
pocono	1

Cluster 3	
reese's puffs	9
nature's path	8
frosted mini-wheats	8
cheerios	8
chex	8
honey bunches of oats	5
envirokidz	3
fiber one	3
great grains	2
barbara's	2
mom's best cereals	2
special k	2
kind	2
wheatena	2
staysteady	2
ezekiel	2
alpen	2
scott's porage oats	1
general mills	1
oatmeal squares	1

Cluster 4	
nature's path	16
barbara's	11
cheerios	7
great value	5
ezekiel	5
chex	4
special k	4
bariatricpal	3
arrowhead mills	3
mom's best cereals	3
general mills	3
envirokidz	3
wholesome provisions	2
hersheys kisses	2
oatmeal squares	2
uncle sam	2
lucky charms	2
think	2
funko	2
kix	2