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Statistical Modelling in User Experience Design of Detergent Packages †

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Abstract

A method for user experience design of detergent packages is proposed. Using a checklist, user experience with detergent packages is assessed. Through a statistical model, the most important package design elements, which provide positive emotional user experience, are determined. User experience design recommendations for good and bad design of detergent packages are defined. Within a case study, the method was experimentally used for design of detergent packages. Further research in this new and very promising area is discussed.

Keywords: user experience; Kansei engineering; detergent packaging; PLSR; emotional design; statistical modelling

1. Introduction

Consumer perceptions and emotional responses to a product play a crucial role in purchasing decisions. "The creation of appealing packaging must take into account the emotional reactions they trigger in consumers" [1,2]. To incorporate these emotional considerations into packaging design, firms must adopt techniques that translate subjective and unconscious emotional responses into tangible design features [3,4].

Designers typically begin with user requirements, prioritizing both functionality and visual appeal in package interaction. Establishing a user-friendly and manageable packaging process fosters a positive user experience, which is fundamental to influencing consumers' buying decisions [5–7].

Packaging design transcends visual appeal; it integrates the consumers' thoughts, emotions, and actions to forge a lasting emotional bond with the detergent. Factors like tactile feedback, visual appeal, and user-friendliness play a critical role in shaping favourable brand perception.

A method for gathering UX data through interaction with detergent packages is proposed and illustrated through a case study [8]. Design guidelines are established and applied to create an optimal detergent package solution.

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2. Method for User Experience Design of Detergent Packages

The method includes UX evaluation followed by statistical modelling and analysis of the collected data [9–14].

In **step one**, a checklist is defined and used to assess user impressions of pre-selected detergent packages using a 5-point semantic differential scale [15,16].

In **step two**, packages are assessed using Kansei words [17].

In **step three**, statistical modelling is performed. Due to the large number of variables and multicollinearity, a Partial Least Squares Regression (PLSR) model is applied [9,11,13,18]. Ordinary Least Squares (OLS) is unsuitable because correlated independent variables violate model assumptions. PLSR instead finds multidimensional directions in the X-space that best predict Y.

In **step four**, design recommendations are derived from the statistical analysis.

In **step five**, an optimal UX-driven detergent package is designed. The method steps are shown in Figure 1.

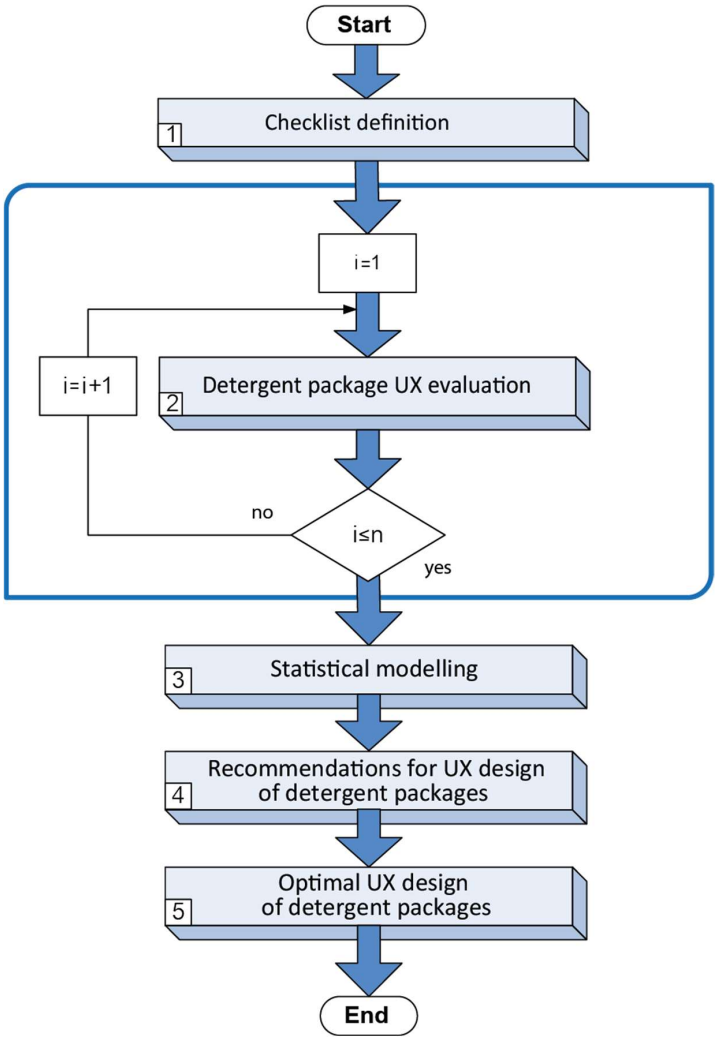


Figure 1. Method steps for UX design of detergent packages.

3. Case Study

The method proposed is illustrated by a case study of eleven detergent packages from package brands available on the market.

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Within the process of creating the checklist (**step 1**), four pilot tests with small groups of five participants (students at the Department of Industrial Design Engineering of Technical University of Sofia) were performed.

In the **second step**, 70 users (BSc students in industrial design engineering) rated their experience with 11 detergent packages for 23 design elements comprising 72 units using 21 visual, tactile and usage Kansei impression words.

In the **third step**, statistical modelling and analysis of UX data was performed. Because of the large number of variables (23) and their units (72), a multivariate statistical PLRS model was applied.

All design elements (23) and their 72 units are represented as independent variables, and all Kansei word pairs describing user experience (visual, tactile and usage) are presented as 21 dependent UX variables. Some of the regression coefficients obtained are show in Table 1.

Table 1. Some regression coefficients of detergent package design elements.

Detergent Package Design Elements		Design Units	Regression Coefficients	Detergent Package Design Elements		Design Units	Regression Coefficients
1.	**Package Shape**	Square 1 Trapezoid 2 Polygon 3 Cylinder 4 Cone 5	0.1082 −0.1142 0.0191 0.0044 −0.0328	**6.**	**Package Width**	High 1 Average 2 Narrow 3	−0.0845 0.0275 0.0425
2.	**Value Image**	Dark 1 Neutral 2 Contrast 3 Light 4	−0.0456 −0.0842 0.0261 0.0782	**7.**	**Image Size**	Large 1 Medium 2 Small 3	−0.0199 0.0009 0.0327
3.	**Position of Trade Name**	Above 1 Below 2 Left 3 Middle 4 Right 5 Top Left 6 Top Right 7 Bottom Left 8 Bottom Right 9	−0.0065 0.0817 0.0442 −0.0343 −0.0005 −0.0122 0.0519 0.0064 −0.0982	**8.**	**Package Height**	High 1 Average 2 Low 3	0.0548 0.0326 −0.0758
4.	**Logo size**	Large 1 Middle 2 Small 3	−0.0315 −0.0533 0.0857	**9.**	**Font Trade Name Optical Value**	Bold 1 Semi-Bold 2 Light 3	0.0670 −0.0216 −0.0548
5.	**Style of Letters in Trade Name**	Capitals 1 Upper Lowercase 2 Lowercase 3	−0.0025 −0.0456 0.0737	**10.**	**Dosimeter**	Unavailable 1 Available 2	−0.0293 0.0293

The regression coefficients concerning the values of visual, tactile and usage impressions for all 72 categories of the 23 design elements were taken from the total UX data set. For all 21 Kansei word pairs, statistical analysis was performed to find the most important design elements above the mean for the specific SD.

The range of the regression coefficient values was calculated from the regression coefficients of design units for each of the design elements. The distribution of all 72 values of UX impressions for the design elements and their units above average values (0.0981) is presented in Table 2.

Table 2. Some design recommendations including the most important detergent package design elements.

Detergent Package Design Elements	Range	Good Design	Bad Design
1. Package Shape	0.3782	Square 1	Trapezoid 2
2. Value Image	0.1819	Light 4	Neutral 2
3. Position of Trade Name	0.1623	Below 2	Bottom Right 9
4. Logo Size	0.1502	Small 3	Large 1
5. Style of Letters in Trade Name	0.1346	Lowercase 3	Upper Lowercase 2
6. Package Width	0.1339	Narrow 3	High 1
7. Image Size	0.1337	Small 3	Large 1
8. Package Height	0.1254	High 1	Low 3
9. Font Trade Name Optical Value	0.1047	Bold 1	Light 3
10. Dosimeter	0.1007	Available 2	Unavailable 1
Average of All 23 Design Elements	0.0981		

The most important design elements and their recommended design units with range values above the average value (0.0981) for the positive impressions of the consumers are the following: package shape (0.3782)—square, value image (0.1819)—light, position of trade name (0.1623)—below, logo size (0.1502)—small, style of letters in trade name (0.1346)—lower case, package width (0.1339)—narrow, image size (0.1337)—small, package height (0.1254)—high, front trade name optical value (0.1047)—bold, and dosimeter (0.1007)—available.

The non-recommended design units (bad design) for the relevant design elements' values are as follows: package shape—trapezoid, value image—neutral, position of trade name—bottom right, logo size—large, style of letters in trade name—upper lowercase, package width—high, image size—large, package height—low, front trade name optical value—light, and dosimeter—unavailable.

In the **fourth step**, UX design recommendations for detergent packages are defined (cf. Table 2). They can serve as a basis for introducing well design practices in detergent package design.

In **step five**, an optimal detergent package was designed based on UX design recommendations. It combines the best UX evaluations of user impressions from UX assessments. The optimal package is expected to trigger a positive user experience due to the optimal values of design elements presented in Figure 2.

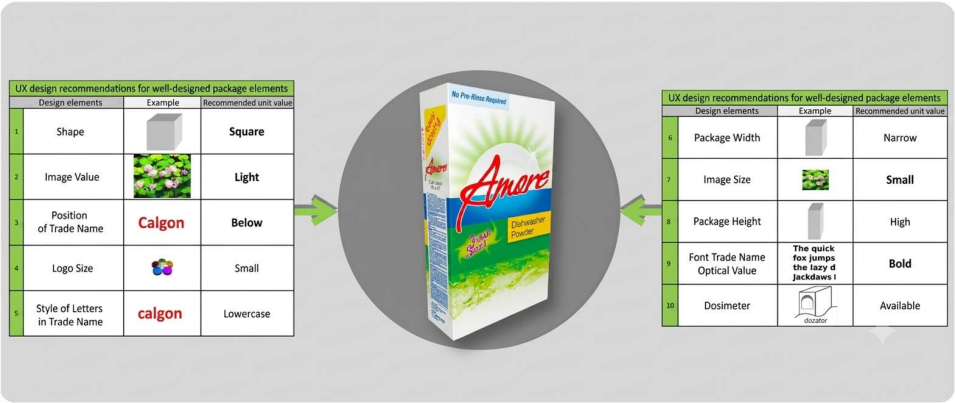


Figure 2. UX design recommendations for well-designed detergent package.

4. Conclusions

A method focusing on the impact of user experience on design is proposed to highlight recommendations that could help designers to determine the most important design elements in detergent package design. It uses user experience design to stimulate, attract, and convince customers, and motivate their buying behaviour and decision-making. It was found that it is possible to measure emotional user experience through a statistical model. User experience recommendations for detergent packages are defined. This research presents a first step in this very promising research field of emotional user experience detergent package design.

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Institutional Review Board Statement: Ethical review and approval were waived for this study due to the non-invasive nature of the survey, which involved only anonymous evaluations of detergent package design elements by adult participants without collecting personal or sensitive data.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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Abbreviations

The following abbreviations are used in this manuscript:

UX	User Experience
PLSR	Partial Least Squares Regression
OLS	Ordinary Least Squares
SD	Semantic Differential

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