Agile and Reliable Design Decisions Based on the Perception of the Target Audience

Waumap Plataform: Methodological Tool to Involve Potential Consumers in the Design Process

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***Abstract*—The conceptualization phase of a product plays a critical role in the design process as the decisions made during this phase directly affect the competitiveness of the product. During this phase, making decisions correctly becomes a very important activity for the company. However, decisions made during this phase often rely on subjective opinions, leading to uncertainty and errors, and consequently, high failure rates in the launch of new products. Few companies conduct user research studies due to the substantial time and cost investment, requisite expertise, technological resources, and access to adequately representative user samples necessary to obtain robust and reliable insights into people' preferences. This complexity makes such studies impractical for everyday design decision-making. In this context, this paper presents a methodological tool that allows companies to make objective decisions in the early phases of their design process. This tool takes advantage of the potential of Artificial Intelligence (AI) to analyze in a standardized, agile and autonomous way the perception of the consumer expressed naturally by a representative sample of remote users, combining classical qualitative user research with natural language processing techniques. The methodological tool has been validated through use cases from companies in different sectors in which remote tests have been carried out with representative samples of users, showing its suitability to obtain in a robust, reliable, agile and economical way the design optimization keys from the point of view of market acceptance.**

Keywords- market research solution; user insights; emotion design; decision-making; NLP.

I. INTRODUCTION

The conceptualization phase of a product plays a critical role in the design process. The decisions made during this phase directly affect the degree of innovation, quality of design solutions, costs involved, and overall competitiveness of the product. During this stage, companies continuously accept and reject options, making it critical to make informed and appropriate decisions [1]. However, decision-making during this phase largely relies on internal groups and collaborative sessions, which are highly subjective and influenced by the design team's perceptions, tastes, knowledge, and previous experiences [2]. This often leads to uncertainty and errors during the design process, which is evident from the high failure rates of Fast-Moving Consumer Goods (FMCG) launches. Nielsen [3] reports that 76% of FMCG launches fail in their first year of life, primarily due to the failure to address consumer needs or frustrations.

To address this issue, some companies conduct user research studies during the strategic definition phase to identify design requirements that cater to the needs of their target audience. However, these studies employ traditional market research methodologies, such as surveys, focus groups, and interviews, which are time-consuming and expensive. Furthermore, these studies are conducted at the beginning of the process, limiting the flexibility to respond to market changes in later stages of development.

Moreover, marketing and user research managers in companies face constraints in terms of time and resources [4], resulting in a reduced frequency of these studies. Delaying involving potential consumers until the final validation stage increases the cost of development modifications significantly. According to Forrester [5], the cost of fixing a design problem after launch is 100 times higher than if it had been identified and rectified in the early stages of development.

When studies are conducted during the design phase, companies typically employ cost-effective and swift techniques, such as surveys or AB tests. While these methods allow companies to decide on a design alternative among several options, they fail to provide information on the reasons for the preference or the related design elements, limiting the scope for maximizing customer satisfaction. In this context, there are user research techniques that focus not only on investigating user preferences but also on transferring them to the design elements of the product, such as Kansei Engineering, Conjoint analysis or the Repertory Grid Technique [6]. Another type of techniques used to design products are neuroscientific techniques, which allow us to know the influence of different attributes of the product (color, packaging...) on target audience' impact [7], being EEG and eyetracking the most used by researchers [8]. The drawback of this type of techniques is that they require slow and expensive research work with users, as well as an analysis and interpretation of complex results for the daily decision making of companies during their design process, an aspect that goes against the need to reduce launch times due to the continuous reduction of product life cycles.

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For this reason, the development of a user-centered design methodological tool is planned to allow companies to make objective and reliable decisions in early phases of the product development process, replacing the most frequent approaches of decision-making based on intuition.

The main hypothesis of this research work was that the remote capture and subsequent automated analysis, employing AI algorithms, of the naturally expressed perception of a representative sample of potential users when faced with certain design alternatives, would obtain, in a simple and agile way for companies, key indicators for the optimization of the design in relation to market acceptance. While remote testing has inherent limitations, particularly the inability to present the physical product, it is deemed a favorable approach for approximating the capture of users' initial impressions during the early stages of development.

In order to achieve the proposed hypothesis, a methodological tool that incorporates AI has been developed using the "Customer Development" methodology [9], as explained in section II. Section III describes the results of 11 use cases from companies in different sectors and section IV, the reliability and robustness of the tool. Finally, the conclusions and future work of the study are shown in section V.

II. A New Methodological Tool for Including Potential Consumers in the Design Process

This section describes the tool developed, as well as the methodology followed for its development, considering the market problem.

A. *Final Design of the Methodological Tool for Design Decision Making*

To address the need for more efficient and effective methods for including users in the product development process, the Instituto de Biomecánica (IBV) has developed the Waumap methodological tool [13]. IBV has more than 40 years of experience providing advisory services to companies for designing target audience-oriented products using the People Oriented Innovation (IOP) methodology [6].

This tool helps companies to make design decisions in early phases. It allows companies to carry out design testing with a representative sample of their target audience, obtaining key indicators for optimizing the design from the point of view of maximizing its positive perception.

Waumap tool utilizes AI to analyze consumer perceptions of various design alternatives in a standardized, agile, and autonomous manner, allowing companies to make reliable and objective decisions during their design processes.

The Waumap study is conducted in three simple steps:

1. Defining the test based on two images or videos and the characteristics of the target audience. The test comprises a survey (with concepts defined by the company) and analysis of natural language using AI from open opinions expressed freely. Eye-tracking may also be incorporated.
2. Launching the remote study to a database of potential users that fit the defined profile.
3. Automatically generating a report, which can be received within 7 days of launching the study. Figure 1 shows an example of a Waumap report. The Waumap report provides information on the factors driving preference and the emotions evoked by each design alternative through opinion polarity analysis. The eye-tracking feature generates heat maps displaying the areas of greatest visual attention.

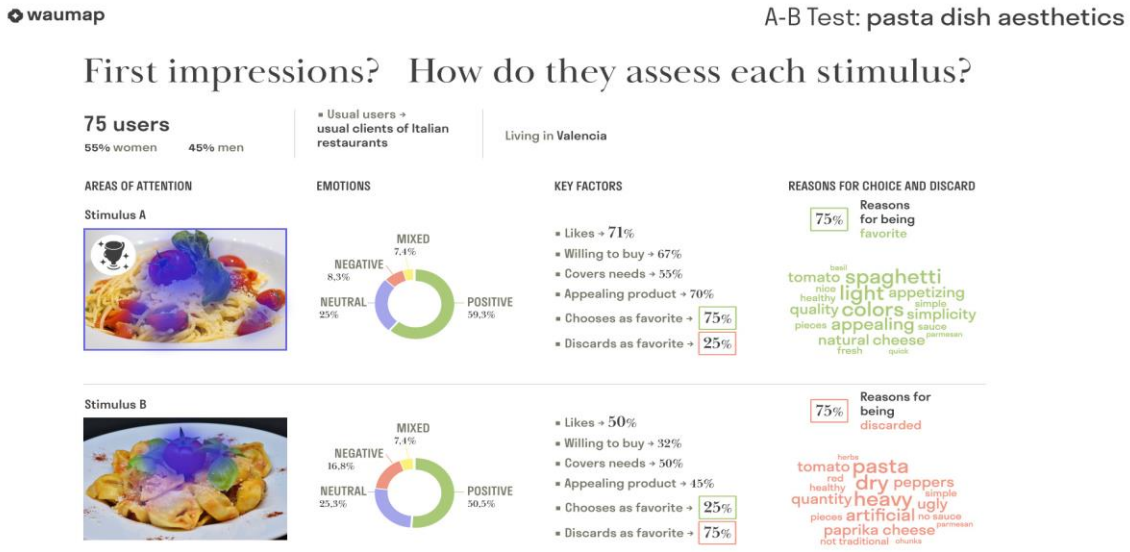

Figure 1. Waumap test AB eye tracking report

The table below provides a detailed description of the methodology to obtain the key variables of the Waumap report by automatically recording and analyzing user perceptions.

TABLE I. WAUMAP METHODOLOGY

Variables	Recording techniques	Analysis techniques
Areas of greatest visual attention	Gaze tracking recording via webcam.	IBV's own programming using OpenCV Models.
Emotions (positive-negative-mixed-neutral)	Recording of first impression expressed in a natural way, either by voice or text.	- Amazon Transcribe. Amazon Web Services (AWS) automatic speech recognition service that facilitates speech-to-text conversion. It provides the transcribed text, as well as confidence scores between 0 and 1 (self-assessments by the service on how well it may have transcribed the text). It is used to convert the first impression expressed naturally by voice into text. - Amazon Comprehend. AWS natural language processing (NLP) service that allows, using machine learning techniques, to analyze and understand the meaning of text in different languages. Specifically, the Waumap tool uses the "Detect Sentiment" function, which analyzes the text and determines the polarity of the sentiment, i.e. whether the text is positive, negative, neutral or mixed. This function returns an inference of the predominant sentiment and provides for each sentiment the probability between 0 to 1 that it has been correctly detected.
Key factors	Closed survey with concepts, to know the perception of the design alternative in some concepts predefined by the company. The ordinal Likert scale of 5 categories has been defined, as it is the most used scale in market research and easy to answer (Likert, 1932), being 1 the value associated with the most disagreement (e.g., I do not like it at all) and 5 the value associated with the most agreement (e.g., I like it a lot).	Calculation of the total % of participants with answers classified as positive grouped in Top 2 Box value, i.e., percentage of people who select for each survey concept the two most positive values.
Favorite design alternative	Prioritization of design alternatives, clicking on the favorite stimulus.	Calculation of % of participants selecting and discarding each design alternative as favorite.
Reasons for choice and discard	Justification of the reasons for the prioritization of design alternatives, expressed in a natural way by text.	- Natural Language Toolkit (NLTK). A set of Python libraries and programs that facilitate natural language processing, such as the "nltk.corpus" library which provides access to a variety of corpora (text datasets). Among them is "Stopwords" which contains a predefined list of common words that do not provide value for text compression, such as articles, prepositions and conjunctions. - Wordcloud. Python function that generates a visual representation of the words in a text, where the size of each word represents its frequency. Prior to such visualization, natural language processing is required, such as the elimination of common words with the "Stopwords" function. In the Waumap tool, word clouds are represented for the selection and discard reasons for each design.

B. Definition of a Methodological Tool taking into account Market Needs

The development of this tool was carried out using the “Customer Development” methodology, which aims to understand the market problem and validate that the proposed solution will indeed meet customer needs and demand, reducing business risks by testing hypothesis [9]. Firstly, hypothesis about its company profile and value proposition were defined, using the “Business Model Canvas” template, a visual chart with elements describing a new business model [10]. On the other hand, hypotheses about the companies' problem and the possible solution were specified. These hypotheses were classified following the model proposed by Josh Seiden [11], based on risk and uncertainty, for prioritization when validating with companies:

- Risk. If the hypothesis were false, the methodological tool would have a high risk of not achieving market acceptance. The classification based on risk has been carried out at expert criterion.
- Uncertainty. A hypothesis with high uncertainty is a hypothesis with a high unknown (lack of data) regarding its truth or falsity. To classify the hypotheses based on uncertainty, a state of the art on decision making in the design process of companies has been carried out.

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After the definition and prioritization of the hypotheses related to market acceptance, test cards [11] were developed for the definition of the experiments to be carried out to validate the most critical hypotheses and with greater uncertainty. In the experiments, Minimum Viable Products (MVP) of Waumap tool were used.

To validate these hypotheses, from the beginning of the research work, a sample of 11 Valencian companies with variability in sectors and type of products (food, distribution, home, clothing, cleaning, advertising and tourism) collaborated and were interviewed after the experiments. The interviews lasted 30 minutes and followed the guidelines recommended in the book "Lean Customer Development" [9].

Table II shows the results of the hypothesis validation.

TABLE II. RESULTS OF THE HYPOTHESIS VALIDATION

Hypothesis	Experiment results
The Waumap results are useful for its decision making	True. 8 of the 11 companies (> 60%) affirmed that waumap results are credible and clear for its decision making.
Waumap tests help the company in its decision-making processes	True. 10 of the 11 companies (> 60%) named design problems of their company to test with waumap.
Companies have adequate material to evaluate different design alternatives in Waumap	True. 8 of the 11 companies (>60%) provided stimuli of a design problem relevant to their company
Waumap fits into the company's daily taks (actions to be carried out, availability...)	True 8 of the 11 companies (> 60%) completed the configuration process of a Waumap test and valued its ease of use.

Another parameter to be defined prior to the final development of the tool was the sample size. To optimize the number of users needed to obtain reliable conclusions, a pilot study with 5 Waumap tests was conducted to estimate the effect size of the variable "favorite design alternative" (see Table I). Table III shows the value of this variable in the 5 tests.

TABLE III. DIFFERENCES BETWEEN THE PREFERENCE OF DESIGN ALTERNATIVES

Waumap Tests	Favorite design alternative	Preference differences
Casual footwear Test	Stimulus A by 52%	4% (52%-48%)
Advertising campaigns Test	Stimulus A by 57%	14% (57%-43%)
Cleaning products Test	**Stimulus A by 65%**	**30%** (65%-35%)
Hotel rooms Test	Stimulus A by 75%	50% (75%-25%)
Pasta dishes Test	Stimulus A by 75%	50% (75%-25%)

After obtaining the results of the tests, it was deemed appropriate to establish an objective with the aim of detecting substantial differentials exceeding 30% in preference among design alternatives. This objective pertains, in particular, to the assessment of designs conducted in the context of the "cleaning products Test", which serves as a representative archetype of the design category slated for evaluation using the Waumap tool, primarily intended for novel product concept assessment.

The appropriate formula [12] with the data of "cleaning products test" was applied for experimental designs (contrast test) in which non-parametric statistical tests are applied (X^2).

$$W = \sqrt{\sum_{i=1}^{m} \frac{(P_{1i} - P_{0i})^2}{P_{0i}}} = \sqrt{\frac{(0.65 - 0.5)^2}{0.5} + \frac{(0.35 - 0.5)^2}{0.5}} = 0.3$$

Cohen's tables [4] were consulted for a test power of 75%, α=0.05 (95% confidence level), u=1 (2 designs alternatives -1) and W=0,3, obtaining n=75 users.

Power of χ^2 test at a = .05, u = 1

	w								
N	.10	.20	.30	.40	.50	.60	.70	.80	.90
25	08	17	32	52	70	85	94	98	99
30	08	19	38	59	78	91	97	99	*
35	09	22	43	66	84	94	99	*	
40	10	24	47	71	89	97	99		
45	10	27	52	76	92	98	*		
50	11	29	56	81	94	99			
60	12	34	64	87	97	*			
70	13	39	71	92	99				
80	15	43	76	95	99				
90	16	47	81	97	*				
100	17	52	85	98					
120	19	59	91	99					
140	22	66	94	*					
160	24	71	97						
180	27	76	98						
200	29	81	99						
250	35	89	*						
300	41	93							
350	46	96							
400	52	98							
500	61	99							
600	69	*							
700	75								
800	81								
900	85								
1000	89								

Figure 2. Cohen tables for sample size stimation.

III. USER COMPANIES' FEEDBACK OF THE WAUMAP TOOL FOR PRODUCT DEVELOPMENT

After conducting the "Customer Development" methodology with the collaborating companies, the potential company profile of the methodological tool, and their needs and demands were identified (Table IV).

TABLE IV. COMPANY PROFILE, NEEDS AND DEMANDS

Sectors	Food, distribution and cleaning. Tourism and advertising.
Main activity	Development of consumer goods, excluding commodity products. Tourism and advertising services.
Other features	• High billing • High investment in R&D before product launch or high product rotation. • Restless, eager to innovate

	• Currently carrying out some testing before launch, even if it is internally. • Awared that company could improve its decision making in the design.
Needs/problems	• Most companies claim to currently spend a lot of time and effort making decisions in the design and launch of products. • They have a lot of uncertainty about the success of new product launches (a company claims that 9 out of 10 products fail). • In general, companies say they do not have the budget to carry out market studies that allow them to predict market acceptance before launch (in addition, these types of studies usually have long deadlines and do not fit into their processes).
Demands/solutions	Companies would like a solution that would allow them… • Reduce the risk of development due to non-acceptance by the market. • Decide/discriminate between different design alternatives. • Know the value proposition of their products/services and also the points for improvement.

Furthermore, the Waumap methodological tool has been validated through various use cases with the 11 collaborating companies. These cases involved remote testing with representative user samples, which demonstrated the tool's effectiveness in obtaining the keys to design optimization. Companies appreciate the tool's simplicity, intuitiveness, and agility, especially in the areas of new product concepts, supermarket shelf (physical and/or virtual), packaging, and corporate image.

The Waumap results have provided valuable insights in the decision-making process, allowing companies to access a representative sample of users remotely and reduce costs in user recruitment, testing, and prototype development. Companies also appreciate the short period of time it takes to obtain results, with reports typically available within a week. The report's clarity and ease of understanding not only helps companies make decisions but also justifies them internally and to B2B clients.

The preference keys obtained through natural language processing analysis provide the most value in decision-making, enabling companies to understand the reasons for preference/rejection and their relationship with the design elements.

IV. REALIABILITY AND ROBUSTNESS OF WAUMAP

This section describes the conducted analyses to show the suitability of the tool for obtaining design optimization keys in a reliable and robust manner.

A. *Reliability of Waumap Tool*

To demonstrate the reliability of the tool, a comparative analysis of the results obtained through a test developed with the Waumap tool and through a classic market research study (two focus groups) was carried out. In these studies, two sauce labels were assessed as design alternatives (Figure 3).

It is worth mentioning that the focus groups were carried out by one of the collaborating companies (Choví), as this was the methodology they commonly used for this type of design problems and the results were not shared until Waumap test was completed.

Figure 3. Design alternatives evaluated in the comparative study.

The results obtained with both tests were identical, obtaining the same design as a favorite and the same reasons for choice and discard.

The comparative study has made it possible not only to demonstrate the reliability of the results, but also to demonstrate the advantages of Waumap tool over traditional studies, as the results are obtained in a much more agile, simple and economical way (see Table V).

TABLE V. COMPARISON BETWEEN WAUMAP TEST AND FOCUS GROUPS

Waumap Test	**2 focus groups**
N=75 users	N=14 users
Reporting deadline: 3 days	Reporting deadline: 3 weeks
Staff hours: 2,5 hours	Staff hours: 45 hours
User gratification cost: 225 euros	User gratification cost: 420 euros

B. *Robustness of Waumap Tool*

To demonstrate the robustness of the tool, the perception results of a sauce packaging, assessed in two different Waumap tests with different samples of users and in different time periods were compared (Figure 4).

Figure 4. Design evaluated in two Waumap tests.

The results related to the first impressions expressed naturally extracted by natural language processing algorithms were similar: polarity of the sentiments and word clouds.

V. Conclusion and Future Work

The analysis of the perception of the consumers who have participated in the Waumap' use cases have allowed to show that the automatic analysis of the user's perception through AI reduces the time and effort of analysis to generate the keys that make it easier for companies to make more informed decisions in the design of their products.

The Waumap tool has a positive impact on the decision-making process, facilitating better integration of the target audience in the product conceptualization phase by a simple, intuitive and agile process. Furthermore, this methodological tool provides key insights into design optimization from the perspective of market acceptance, with particular utility evident in the following application domains: new product concepts, supermarket shelf (physical and/or virtual), packaging and corporate image.

The following future lines of work have been identified:

- Including more than two design alternatives in the Waumap test.
- Exploring sentiment analysis by also analyzing tone of voice.
- Obtaining and validating a preference prediction model based on sentiment polarity, when more data is obtained with future use cases.

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