Emotional Crowdsourcing Tool Design for Product Development: A Case Study Using Local Crowds

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Abstract. Crowdsourcing is a useful tool for new product development and business innovation. To maximize its utility, regarding a crowdsourcing tool as an everyday thing used by crowds, in this paper, we integrate emotion and emotional design into a human-centred design process with local crowds and showcase an emotional crowdsourcing platform (tool) design for product development. In order to transform emotional design principles into the emotional crowdsourcing tool design, making it useful, usable and pleasurable, we first prototype a suitable emotion/emotional design process, and then identify a set of emotions and corresponding design features applicable for a crowdsourcing platform design and gain better understanding of common key concerns affecting the users' satisfaction of a platform. Finally, we identify a set of operational toolkits with emotional design features.

Keywords: Emotional Design · Crowdsourcing · Platform Design · Product Development · Emotional Design Features · Human-Centred Design

1   Introduction

Demand for mass personalization of products now drives innovation of product design and development. One of the key enabling technologies is crowdsourcing-based digital platform for product design and development. However, existing crowdsourcing platforms for product design have some barriers for design and manufacturing businesses to adopt them in practice [1]. The main barriers are (1) effective involvement with crowd-workers and field experts, (2) the designers' trust of problem-solving ability and quality on a platform, and (3) the users' enjoyment of using such a platform (the users here refer to both the designers and crowd-workers). These factors together cause the overall satisfaction problem to a platform. Therefore, how to design and make a

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crowdsourcing platform (tool) appealing to both the business (the designer) and the crowd workers is a great challenge.

In this research, we regard a crowdsourcing tool as an everyday product used by both designers and crowds. Design of everyday product was previously focused on its usability, aiming to making the product useful and usable [2]. Since Norman [3] set forth the emotional design theory and principles, the design of everyday product has emphasized on emotional design for moving beyond usability to fun and pleasure. Norman's emotional design builds on the three interconnected layers: visceral design, behavioral design and reflective design. It is believed that Norman's emotional design theory can be applied to product and service design. However, there is no explicit emotional design process/method to guide emotional design. Now the question is how to transfer the emotional design theory into design practice [4], for example, a crowdsourcing-based new product development platform design in terms of its interface, key functions, tools, and interactions?

Emotion [5] is generally defined in terms of subjective experiences or feelings, goal-directed behaviors (attack, flight), expressive behavior (smiling, snarling), and physiological arousal (heart rate increases, sweating). Emotion is linked to motivation [5] and as a readout mechanism associated with motivation. Buck in [6] structures emotions into biological emotions (such as love and bonding) and higher-level emotions: Social emotions (such as pride), cognitive emotions (such as surprise, interest and curiosity) and moral emotions (such as feelings of distributive and retributive justice).

Closely related to emotional design, designing emotions [7] and designing pleasurable products [8] are premier references in design research. Desmet in [9] proposed a multi-layered model of product emotions including surprise emotion (such as surprise, amazement), instrumental emotion (e.g. disappointment, satisfactory), aesthetic emotions (such as disgust, attracted to), social emotions (e.g. indignation, admiration) and interest emotions (e.g. boredom, fascination) and developed the PrEmo tool [10] for measuring product emotion. In general, emotion as part of user experience, emotional design in practice is also associated with design for fun [11] and design for user experience (UX) [12] in the human computer interaction research field [13].

Since there exists no clear emotional design process for conducting emotional design practice but certain difficulties in quantitatively assessing emotions [14,15] and emotional design [16], we have used general human-centered design processes and methods in our case study and conducted a qualitative study on our emotional crowdsourcing tool design. To gain a better understanding of the problem and identify possible solutions, we use the layout design of a kitchen bar with virtual crowdsourcing platform in the case study.

In this case study, we use local crowds in a co-design process, at the idea/concept development stages, they are acted as designers to conduct designers-driven emotion design, at the evaluation stages, they are acted as users to conduct user-driven emotional design. The relationships between the emotion design and emotional design can be found in [17].

The goal of this study is to integrate the designers-driven emotion design and the users-driven emotional design principles [17] into a human centered design process, apply it to a crowdsourcing tool design and hope to develop an emotional design process. The key contributions are following:

- Prototyping a suitable emotion/emotional design process

- Identifying a set of emotions and corresponding design features applicable for a crowdsourcing platform design
- Understanding of common key concerns affecting the users' satisfaction of a platform
- Identifying a set of operational toolkits with emotional design features

2   Related Work

In order to make a crowdsourcing platform appealing to use, the related work in crowdsourcing field includes: gamification, pricing, incentives, notifications, engagement improvement and task recommendations.

Gamification. Both gamification and crowdsourcing mechanisms share common features in engaging users to participate and contribute, thus, gamification [18] was used in crowdsourcing as engagement techniques for human rights organizations. Aiming to improve performance of campaigning systems of human rights organization, Zeineddine in [18] investigated psychological motivations behind user's engagement. The study provided system design insights in not only crowdsourcing but also interactive social platforms.

Researchers [19] from the University of Amsterdam and IBM Research team combined gamification techniques and crowdsourcing to create an engaging game "*Dr. Detective*" with a gold standard in medical text. The research proposed a design for a gamified crowdsourcing workflow to create an annotated version of medical text. Results from a pilot study have confirmed the usefulness of this gamified crowdsourcing model in medical field. While researchers [20] from the University of Bath argued that to support fairness in collaborative online systems, visual representations like meters in an online game can enable basic inferences about contributions and fairness. This finding is constructive for designing collaboration mechanisms in terms of gamification on the crowdsourcing platform.

Pricing. The work in [21] studied pricing mechanisms for crowdsourcing markets, which introduced the basic framework of designing mechanisms for crowdsourcing market. To maximize tasks and minimize payments, the researchers came up with the platform Mechanical Perk(MPerk) on top of Amazon's Mechanical Turk(MTurk), which provides a good basis for designing pricing mechanisms for crowdsourcing markets that can be even further extended. Others [22] developed an efficient and truthful pricing mechanism (TruTeam) for team formation in crowdsourcing markets. Among four different incentive mechanisms: profitability, individual rationality, computational

efficiency and truthfulness, simulations confirm that the superior mechanism is an efficient and truthful pricing mechanism for crowdsourcing markets.

Incentives. The problems in designing effective incentives are discussed in [23]. While existing research have used incentives to improve participation, this research demonstrates the choice of incentives may introduce a bias against different participants demographically. This study suggests utilizing rewards to target desired participants and using various incentives to improve participation diversity. It is noticed [24] that incentives of workers, which are not aligned with requesters, are affecting the quality of crowdsourcing work. To address this issue, researchers in [24] introduced approval voting coupling with incentive-compatible compensation mechanism. The incentive mechanism is proven through the preliminary experiment conducted on Amazon Mechanical Turk. It is also found in [25] that per-task payments on crowdsourcing platforms reduce productivity, although paid crowdsourcing marketplaces are gaining popularity. Among three tested incentive approaches including methods of bulk, coupons, and material goods, the study found that task completion rate increases when participants get paid. Material incentives generally decrease participation over time. Therefore, it is proposed to apply alternating payment mechanisms, which can lead to more work output and higher earnings for workers.

Notifications. The study [26] indicated that information notification system of crowdsourcing is potentially an important tool for developing nations to utilize. However, current limitations such as unstable electronic communication infrastructure are hindering the information providing in real-time notification system in developing countries. To overcome this issue, the study proposed to use SMS as a reliable method to deliver real-time message. The prototype of this idea used prediction algorithm of user behaviors to ensure a better reward and engaging platform.

It is also noticed in [27] that designing effective performance feedback notification systems can stimulate content contribution. Feedback framed either pro-socially or pro-self has positive effect on content contributors, with a gender different response to competitively framed feedback. This finding provides implication on designing notification system of crowdsourcing platform.

Engagement Improvement. In [28], authors introduced *taste-matching* and *taste-grokking*, two crowdsourcing approaches that are designed to capture personal preferences. Over the testing of generic users, both approaches showed improvement in engagement despite different advantages and drawbacks depending on complexity and variability of the task. The problem of how to engage users' interests besides extrinsic rewards is also studied [29]. The research results suggest positive relationships between user's motivation and engagement to a task, and between user's interest to the topic and their motivation. The results provide a preliminary design guideline for a crowdsourcing environment. The idea of intrinsic benefits is essential to helper when the contribution is voluntary. On the other hand, organizations who seek help can increase task

attractions by framing the issue in an engaging way that may seem more interesting to the contributors.

Task Recommendation. The importance of having task recommendation in crowdsourcing systems was discussed in [30]. The research results show that combining worker performance history and task searching history can better reflect accurate recommendations that suit worker's interests. Creation of multi-label classification and taxonomy [31] is also important to task recommendation. By tracking the potential helper's location, the location-based recommendation technique [32] can direct people to nearby regions where help is needed and direct their attention based on previous task history for better task recommendation.

In general, there lacks emotional designs approach in crowdsourcing platform design. Here, we focus on the crowdsourcing platform design issues with a new lens of emotional design in the context of supporting new product development.

3   Research Method Design

We follow the human-centered design principles and apply the research-through-design approach to design our investigation processes. The research activities were carried out through 4 workshops and 2 focus groups over 10 weeks. These activities follow the double-diamond design process model in the case study.

Case Selection. At the preparation stage, first, we used a group discussion among the researchers in the Design Lab, University of California, San Diego to decide to convert the current Design Lab into a kitchen bar as a business proposition and outsourcing the kitchen layout design as a case study. The reasons for choosing a kitchen bar design for the case study has twofold. One is that the primary functions, appliance and furniture associated with a kitchen bar are easy to understand for participants. The other is that the workshops and focus group studies will be conducted in the Design Lab thus the participants are easy to refer to it during their research. In addition, based on the case selection, we designed and produced a mini-project briefing document including the following information: the project lead researcher, the Project title- A Case Study of Transferring Norman's Emotional Design Theory into a Crowdsourcing Platform Design, the project background on emotional design and crowdsourcing, the project key purposes/activities and the project time line.

The case study was to redesign the current Design Lab as a Kitchen bar and create a new layout design for the kitchen bar in the Atkinson Hall at UCSD campus. Dimensions could be measured by crowd researchers/participants. Assuming a kitchen layout design project manager can access a crowdsourcing platform and the platform managers to help carry out the kitchen bar layout design from the crowds (both individual crowds and business crowds-company users).

Participants as Crowd. Next, we recruited the workshops/case study participants. There were around 150 research assistants registered on the Design Lab and potentially

available for the project. We then issued a call for project participants via email to all of them with the project briefing document. We received 25 replies to express their interests in participation. We then used Doodle to vote and identify most common available time. Based on the most available time, the project selected 17 workshop participants. They are all undergraduates (about half of them are male), 12 majoring in cognitive Science-HCI, 1 in Communication, 2 in Math/Computer Science, 1 in management and Business Studies and 1 in BioEngineering/BioInformatics. We also recruited an Interior Designer and design researcher to participate the workshops. So in total, we had 18 participants in our workshops.

Co-Creation. At the second stage-workshop studies, before a workshop started, we published the workshop activity plan with main questions to answer and related background and research information. The workshop activity plan was published as Google Docs for all participants to share, co-creation and co-editing. After the workshop, the outcomes from the workshop were summarized by the Lead researcher and included in the next consecutive workshop activity plan. Therefore, next workshop activities are well connected to previous studies. Workshop activities include a workshop briefing, brainstorming, group discussions, post-it and voting, and prototyping and simulations.

Use Project Stage-Gates Model as Guiding. During this second stage, we spent four workshops to explore (1) what are emotions that could be embedded in a crowdsourcing platform (2) what are key problems along a project development line and (3) what are key functions/tools needed for solving the problems. Most of participants know crowdsourcing systems such as Amazon MTurk, and Human Intelligence Tasks or HITs based problem-solving styles. Arguably, this HITs-based crowdsourcing tool is not very popular in product design field because it lacks supports for a design project development as a whole. While our emotional crowdsourcing tool is expected to support activities along a whole design project development process, thus, in our research, we use the project stage-gates model to guide our explorations with six stages: Discovery, Scoping, Business Case, Development, Test and Launch.

In the above studies, crowds worked as the crowdsourcing platform designers to conduct *emotion design* as discussed in [17].

Simulation. At the third stage, we conducted two focus-group-based simulation studies. Each focus group had 7 participants (picked from the previous workshop participants). In the first focus group, each participant was assigned a role working with the crowdsourcing tool, and as role players, participants simulated key activities for his/her role along a product design project process based on the six stages on the Stage-Gate model. The purpose of this Focus group was to produce a list of key functions/tools needed. The second focus group simulated a kitchen bar layout design via a prototype crowdsourcing tool to verify, refine and update the key functions/tools list.

In the last focus group, first, the key functions/tools were ranked based on the participants' voting. Then the 6-3-5 brainWriting method was used to create ideas to develop emotional design features for 6 top ranked operational tools and finally, the participants voted for best ideas.

In the simulation studies, crowds worked as the end users of the virtual platform to conduct *emotional design* as discussed in [17].

4   Experiments and Results

Emotional Design Process. We used the workshop 1 for participants to understand business needs/user needs at the top stage level of new product development. Research activities include (1) project briefing, (2) Norman's TED talk on Emotional Design (on youtube), (3) demonstration of three crowdsourcing systems: Slack, CrowdSpring and MTurk, (4) human-centered design principles, and (5) emotional design features. The above activities helped the participants to understand different role players such as business requester, crowdsourcing platform and the platform managers, the crowds and helpable companies (business crowds). After the above, we used open discussion, brainstorming, group discussion, post-it and card-sorting to identify an emotional design process for guiding the following-up research activities.

The research results show that the emotional design process has two parts A and B. Part A is about *emotion design* to identify good design experience and emotions from learning and researching and in turn identify good design features. The steps include (1) collect ideas of what good experiences have being used in similar services (learning from experience) (2) identify what design features which enables delivering / provoking good experience, and (3) find out how we can apply such features into our design. Part B is about *emotional design* to apply a human centered design process to a pleasurable UI/UX design for computer supported collaborative work. The key steps are: (1) need finding, user interviews, survey, observation, personas + storyboarding (2) design with low-fi and hi-fi-prototypes, (3) user (usability) testing with observation, and (4) more iterations incorporated with user feedback.

Pleasures, Emotions and Design Features for Consideration. In the second workshop, Participants followed the emotion design process to first identify the pleasures and emotions which could be synthesized in a crowdsourcing tool and then mapped them onto four levels of pleasures by using Designing Pleasurable Product as reference. The goal is to make the tool useful, usable and delightful. The results from discussion, brainstorming and co-editing, are shown in Table 1. Emotions and their associated design features are shown in Table 2.

Table 1. Pleasures and exemplar design features

Expected pleasures	Exemplar design features
Physio-pleasure: sights, sounds, smells, taste, and touch	Colors, shift function, aesthetically pleasing layouts, flat design, minimalism.
Soci-pleasure (derived from interaction with others). It combines aspects of both behavioral and reflective design	Facebook/Slack reactions, Facebook mutual friends/friend suggestions, real time notifications, Twitter mentions, Facebook/Instagram likes, tagging in memes, posting on social media

Psycho-pleasure (deals with people's reactions and psychological state during the use of products at the behavioral level)	Social Media reactions and likes, share features, security of data, context-relevant things, discounts/reward system, daily check-in reward system, Attention-holding data stream.
Ideo-pleasure (signify the value judgements of their owner at the reflective level)	Rating systems, mutual feedback (Uber/Lyft), people you may know, Invite/Referral based systems, secret groups/events, and premium accounts on websites.

Table 2. Emotions and design features

Emotions	Associated design features
Fun	Humor, emoji communication
Happy, proud	Personalization, intonation, reward system
Respect/love	Passion
Surprise/joy	Easter eggs, storytelling

Table 3. Typical questions

Stages	Key questions look like:
S	With reference to the context information, what are key functions the product/system should have? what are estimated costs of developing this product? how many staff are required to run the system/product? could you please vote for top answers for the above questions?
B	Based on the project information, what is your schematic design solution? how many functions are designed in your solution? how long does it take to develop into a full design solution? how much does it cost? could you please vote for top schematic design solutions and comment on your rankings?
D	With the schematic design of the product and project information, what is your full design solution? what are your pickings of appliance? what are information/emotional design embedded? what are your design highlights? how much/long does it need to …? could you please vote for top design solutions and comment on your rankings?
E	Based on the crowd voting from the prior stage, select 2-3 full designs for evaluation including expert reviewing/design reviewing, what is your ranking and comments on each design solution?
P	With new product information, for launching the product with the key product features, how to best organize an onsite launch event? what are best social media platforms for a launch? how to do it?

Common Key Concerns from Both Designers and Crowd-Workers. The third workshop was used to identify typical application scenarios/questions with reference to a design project manager (business requester) might ask for help during a layout design on a simulated platform. The exploration followed the project phase-gate model with mapping to the kitchen design project process model.

We first introduced a kitchen design or in general interior design process and key concerns. Some reference books and kitchen design websites were briefed beforehand. Then the participants were asked either work individually or as a group to discuss, co-

create, co-edit and co-work on the Table 3. As a result, it shows the possible key questions on a mapped stage model: S-scoping, B-building business case, D-development, E-evaluation, and P-product launch. We also ask the participants to indicate who are qualified for answering questions, the answers show that qualified crowds have different profiles such as professional knowledge and experience.

The research results show that designing a product design crowdsourcing platform needs to refer to its design context in term of process, key design issues, knowledge and skills required, standards and key references, etc. This in turn explains why general-purposed crowdsourcing platforms-based HITs are not suitable for product design.

Key Functions/Operational Tools Needed. From the key questions listed in Table 3 can be seen that at each stage, key questions are asked with different orders, therefore, the key questions are context-sensitive and progressive. This kind of features is well mapped to the phase-gate model. Between two phases, there is a gate for decision such as voting or ranking solutions.

At the workshop 4, we simulated crowdsourcing working scenarios based on key questions and possible answers and identified key tools required to support the design project development in an emotional design process. We discussed and agreed on the general relationship between UX, design for fun, emotional design, gamification, and emoji communication. And in general, we believe their relationships are

- *Positive emotion $\rightarrow$ positive mood $\rightarrow$ positive experience*

- *Gamification $\rightarrow$ fun $\rightarrow$ promoting emotion $\rightarrow$ experience*

We divided participants into 4 groups, each representing a role player then we used group discussion, co-creation, group brainstorming, card sorting, voting and co-editing for most useful design tools/functions. The result is a list of functions and tools for performing specific tasks. Users are classified as A—platform administrators, B-business requesters, and C-Crowds.

Table 4. Key functions and tools

Users	Functions/tools
A+B+C	Key facts demo/application stories, Pricing policies, Normal legal/engagement terms, IP Policies, Online forum for feedback/improvement, Messaging board for crowd questions,Facebook feeding on participation activities
B	Registration tool/profiling tool, Pricing tool, Expert reviewing tool
A	Registration tool
B+C ->A	Communication tools: email + phone /social media platforms
B+C	Introduction to the platform, Image + file uploading
A+B	Team tool-flexible control of crowd profiles
C	Pricing tool, Voting tool/ Voting rewards, Registration tool/profiling tool
Back-End	Task evaluation, Task recommendation

Evaluation of Key Operational Tools and Updating. We conducted a focus group study to observe and record crowdsourcing-based design activities on a simulated crowdsourcing platform with the identified tools in Table 4 to refine and update key tools/functions. We used two tables with a splitter to simulate a virtual working environment (without face-to-face communication) between team members. Participants

are 8 people: A-the platform administrator, B-Business requester (or a design project manager), O-an observer for the HCI test (or evaluation), C1 and C2 are two team members working on the Task 1, C3 and C4 on the Task 2, while C5 is a single participant working on T1. Task 1 is to design a kitchen bar from existing layout. Task 2 is to design a kitchen bar from a blank layout.

We used two types of cards to carry out all communications on the crowdsourcing platform. On a card, a co-worker in a team will write down information he/she want to pass and indicate what communication tool/function he/she will use (a White card is for a traditional tool to be used) while a Pink card is for an emotional tool to be used). Tools provided for use include floor plan with existing layout design, blank floor plan, a set of White communication/tool cards, a set of Pink communication/tool cards, pencils and pens, rulers, crayons/color coding labels, scissors and glue.

After analyzing information on the communication cards, we obtained the updated tools (See Table 5) by integrating results from Table 4 and the focus group study.

Table 5. Updated key functions/tools

Functions/tools	Possible realization methods
Introduction to the platform	Animation
Key facts demo	Interactive video ,cartoon /graphics
IP Policies	Reference templates
Online forum/Messaging board	Project message board(PMB)
Social media tools	Private message
Pricing tool	3rd party tool
Review tool	Pitching tool, sharing tool
Registration tool/profiling tool	Intelligent business/crowd profile building
Team-up tool	Team-building tool
Team collaboration	Team message board
Work-sharing, annotating	Document sharing and co-editing tool
Voting tool with rewards	Action recognition tool
Rewarding tool	Expectation estimation tool
Task recommendation	Crowd evaluation tool and task recommendation tool
Task evaluation	Task decomposition and evaluation tool

Note that it is important to have a team-building tool and provide a team message board. A private team share space and a team message board (either the platform provided or social media platform) are used for discussion and co-design.

Key Operational Tools with Emotional Design Features. In the second focus group, we first co-voted on Google Doc for most important tools which should have emotional design features. The result is shown in the Table 6 with higher voting items.

Table 6. Rated functions/tools with emotional design

Functions/tools	Need emotion features
Basic communication tools (email + phone)	*****
Online forum: message & discussion	***
Messaging board for crowdsourcing questions	*****
Team-building tool	***

Work-sharing & annotating	***
Task recommendation	***

5 Discussion and Conclusion

This paper firstly works through a case study using human-centered design and UX design as guides to develop an integrated emotion and emotional design process and identify common question types for a product design project. Secondly, by simulating real design scenarios on a virtual crowdsourcing platform, we identifies the key functions/tools and associated emotional design features. The research results imply that the design process for a general purposed crowdsourcing platform is different from the platform for a product design with requirements on contextual understanding and emotional design. The integrated emotion and emotional design within a human-centred design process sheds light on this direction.

In summary, this paper demonstrates (1) what are design processes to follow for emotional design, (2) what are emotions and corresponding design features could be used for a crowdsourcing platform to support a product design, and (3) what are common interaction tools which should have emotional design features. Through the case study, we have answered the above questions and gained better understanding of a crowdsourcing platform for product design.

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