Pattern Analysis of IDEO's Human-Centered Design Methods in Developing Regions

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While there is increasing interest in designing for the developing world, identifying appropriate design research methods for understanding user needs and preferences in these unfamiliar contexts is a major challenge. This paper demonstrates how to apply a variety of statistical techniques to an online design case study repository, Human-Centered Design (HCD) Connect, to discover what types of methods designers use for identifying user needs and preferences for developing-world problems. Specifically, it uncovers how the following factors correlate to method usage: application area (e.g., farming versus healthcare), affiliation of the person using the method (IDEO designer versus not), and stages of the user research process. It finds that designers systematically use certain types of methods for certain types of problems, and that certain methods complement each other in practice. When compared with non-IDEO users, professional designers at IDEO use fewer methods per case and focus on earlier stages of the process that involve data gathering. The results demonstrate the power of combining data-driven statistical techniques with design case studies to identify user research methods for different developing-world problems, as well as locating which research methods complement each other. It also highlights that professionals designing for developing-world contexts commit more time to earlier stage user research efforts, rather than in concept generation or delivery, to better understand differences in needs and design contexts.
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Introduction

Over the past decade, designers have increasingly applied HCD and user research methods to developing-world issues. User research methods are tools used by designers to analyze the needs and preferences of the people they are designing for. For example, before designing a healthcare monitoring device for rural villages, a designer might travel to representative villages and apply user research methods such as observation or interviewing to uncover the user needs or functional requirements that their design should satisfy.

While design practitioners recognize the importance of using appropriate user research methods, many designers struggle to choose the right method for new and unfamiliar contexts. Should one use the same methods for a project on rural agriculture as one would for maternal health, and if not, which methods work best for each? If one is already familiar with one method, how can one best complement his or her knowledge by selecting new methods that work well together? Answering these questions requires a better understanding of how user research methods complement one another and how their usage changes in new contexts that are radically different from those of the design team.

To that end, this paper demonstrates how to apply statistical techniques to address open questions about how user research methods are used in practice. As an example, it expands the application of design thinking to nonprofits and social enterprises that work with low-income communities by analyzing the usage patterns of different user research methods in the HCD Toolkit developed by IDEO, an award-winning global design firm. In particular, it looks at HCD Connect, an online platform run by IDEO's nonprofit IDEO.org.[2] HCD Connect distributes a user research method toolkit and provides a forum where designers can post case studies of different developing-world problems. These cases describe the user research methods a designer used to address a particular design problem [1,2], and cover the 39 methods included in the HCD Toolkit. HCD Connect categorizes their user research methods across three different design stages:

Hear: Determine who to talk to, how to gather stories, and how to document your observations.

Create: Generate opportunities and solutions that are applicable to the whole community.

Deliver: Take your top solutions, make them better, and move them toward implementation.

After providing some background on development engineering (design for low income or emerging markets) and the application of user research methods in design, this paper poses four research questions, answering them in sequence through statistical analysis of 809 case studies from HCD Connect:

(1) How does method usage vary across the entire case study corpus?
(2) Which methods complement one another?
(3) Which methods were used for different kinds of design for development problems?
(4) How does method usage compare between professional designers at IDEO and the rest of the HCD Connect community?

Prior Research

A brief review of prior work in categorizations of user research methods follows, along with examples of user research approaches in design for development.

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[2]IDEO.org has since change the name of HCD Connect to simply the DesignKit, which can be found at: http://www.designkit.org

Categorizations of User Research Methods. Researchers have been developing and discussing appropriate user research methods for decades, with yearly conferences devoted to the topic (e.g., EPIC).[3] Many authors have written books cataloging or otherwise classifying design and user research methods [3]. Coming from the field of architecture, the work of Broadbent and Ward [4,5] seeks to understand design methods through the lens of how the designed artifact interacts with various stakeholders, such as the humans who use the design or the environment the design will be situated in. Others view design as a temporal process, and organize design methods according to which stage of a design process a method is most appropriate. For example, Jones [6] divides the design process into three sequential stages (divergence, transformation, and convergence), and allocates methods according to each stage. IDEO's HCD Toolkit is most similar to Jones' organization, in that its hear, create, and deliver stages follow each other in time.

Design and user research methods vary along many factors, and their widespread proliferation and expansion have been recently addressed by websites that collect and categorize methods along multiple dimensions. For example, the Helen Hamlyn Centre for Design at the Royal College of Art operates "designing with people" [7], a collection of user research and design methods that categorizes research methods by their inputs and outputs, the stage of the design process, the relationship of the method to the people who will use the design, and the type of interaction afforded by the method. Roschuni et al. [8] use ontologies to not only categorize method dimensions but also understand how those dimensions interact with one another. Their goals resemble those of HCD Connect, in that they are compiling design case studies to act as an educational resource for designers [9]. These case studies and categorizations can then be used to provide recommendation systems that can help designers to select appropriate methods [10,11].

This work builds off of these prior efforts by providing an analysis of user research methods specifically in the application area of design for development. It demonstrates how factors such as problem type affect the type of methods used. Much of this paper's analyses and methods can directly inform current research in categorizing user research methods.

HCD for Development. Design for development integrates appropriate technologies with economic and social development [12–15]. With an estimated purchasing power of $5 trillion, the "bottom of the pyramid" market has motivated new consumer research that explores consumer preferences in design for these emerging regions (e.g., see Refs. [16] and [17]).

In order to develop effective, scalable, and sustainable products or services in emerging regions [18,19], designers need to deeply understand the social factors, cultural context, and needs of their intended users [20]. However, understanding user or customer needs can be challenging when designers come from a different cultural and socioeconomic background than their intended users. Design thinking or HCD methods provide a range of techniques and tools that engage potential users and customers in the design process, identify their needs and preferences, and generate solutions [21–23]. Only recently, HCD methods have been integrated with earlier work in design for development and social innovations [24]. For example, Winter provides an excellent example of work that combines appropriate technology development with design thinking approaches to wheelchair design in the developing world [25,26]. Wood and Mattson [27,28] summarize codesign and user research methods they have found effective on a range of projects in India and Peru.

There are a number of new academic programs in design for development. For example, Amy Smith's D-Lab [29] at MIT uses a capacity building approach [30] to learn users' needs by empowering community members as codesigners in 3–5 week International Development Design Summits (IDDS) to inspire and enable people with a range of expertise (e.g., mechanics, students, teachers, doctors, economists, priests, masons, and artists) to create technologies for poverty alleviation. IDDS brings together over 60 people from more than 20 countries worldwide to form design teams that "increase income, improve health and safety, and decrease manual labor or save time" [31]. Stanford's Change Labs[4] is a new initiative housed within Stanford's Design Program aimed at large-scale transformation to solve humanity's major challenges in water, energy, climate change, and social inequality.

U.C. Berkeley has recently started an interdisciplinary graduate minor in Development Engineering for students in economics, business, social sciences, and engineering, which highlights a wide range of qualitative and quantitative methods to learn about user needs and preferences in order to develop products and services in development settings.[5] This design research is complemented by research in development technologies with the USAID Development Impact Lab.[6]

Research Methods

This section describes the HCD Connect data corpus followed by a description of the specific statistical methods used to answer the paper's four main research questions.

Overview of Data Corpus. The dataset used in this research consists of 809 case studies posted to HCD Connect between June 2, 2011 and September 13, 2013. Each of the cases uploaded by HCD Connect users describes an example where an individual used methods from IDEO's HCD Toolkit to address development-related challenges faced by that individual or his or her organization. Typically, these cases involve a description of the problem the individual was trying to solve followed by a breakdown of which of the 39 methods in the HCD Toolkit the individual used and possible insights that resulted.

The case could be posted during or after a particular project and can range in duration from a single set of tasks performed by one person to a broad project involving multiple people over extended periods of time. These are real cases performed by individuals; however, the specific outcomes of their larger project may not have concluded by the time the case was posted. The cases posted on HCD Connect can represent portions of a particular design process or a snapshot of a completed project, regardless of the overall outcome of the project.

Figure 1 shows an example of what a case study contains: (*a*) text and pictures describing the problem, (*b*) information regarding the user who submitted the case, (*c*) a list of development "focus areas" which categorize what type of problem the case was solving, and (*d*) a list of the HCD Toolkit methods that the case used to address the problem.

For the information regarding the user who submitted the case (Fig. 1(*b*)), the organizational affiliation of the person who submitted the case is classified as a member of "IDEO" if their organizational affiliation contained the string IDEO and classified as "non-IDEO" otherwise. IDEO members are typically industrial designers or engineers within IDEO, organizers within IDEO.org (IDEO's nonprofit arm that operates HCD Connect), or IDEO.org fellows (who are designers that specifically work with IDEO.org). Non-IDEO members come from almost every continent and have occupations that range from directors and managers at nonprofit organizations to freelance designers to design graduate students to entrepreneurs/CEOs to development consultants. The common factor across most members is that their work focuses on development or social programs.

[3] http://epiconference.com/

[4] http://changelabs.stanford.edu

[5] http://deveng.berkeley.edu

[6] http://dil.berkeley.edu

Fig. 1 An example of an HCD case. Some common elements include: (*a*) a title and description discussing the problem and methods used, (*b*) information about the user submitting the case study, (*c*) a list of focus areas applicable to the case, and (*d*) a list of HCD Toolkit methods that the case used

For the list of development focus areas (Fig. 1(*c*)), Table 1 lists the nine possible focus areas, along with how frequently each area occurs in the cases. Focus areas are not mutually exclusive; a case study can include multiple focus areas.

The list of HCD Toolkit methods that the case used (Fig. 1(*d*)) is encoded in a 809×39 binary matrix, where each row is a case, each column is a method, and a cell is one if that method was used in that case study and zero otherwise. A summary of the 39 methods can be found in IDEO's online version of the HCD Toolkit.[7]

Overall, the 809 cases were submitted by 516 users. The 38 IDEO users submitted 120 (15%) of the cases (≈3.16 cases/user). The 481 non-IDEO users submitted 689 (85%) of the cases

[7]http://www.ideo.org/tools

Table 1 Breakdown of the 809 cases by focus area. A case could have multiple focus areas.

# Cases	% Cases	Focus areas
506	62.5	Community development
480	59.3	Agriculture
317	39.2	Education
281	34.7	Environment
225	27.8	Health
140	17.3	Water
124	15.3	Gender equity
97	12.0	Energy
92	11.4	Financial services

(≈1.43 cases/user). The most cases submitted by a single user was 12 cases, while the majority of the cases were submitted by different users, so it is unlikely that a single user's opinion or preferences biased the below patterns observed in the dataset.

Overview of Statistical Methods. This paper demonstrates how to apply various statistical techniques from nonparametric statistics and large-scale hypothesis testing to answer four research questions about how designers use methods in design for development to identify user needs and preferences. Before presenting the results, this section reviews the different statistical analysis methods used to answer each of the four research questions:

(1) How does method usage vary across the entire case study corpus? The binary matrix from Fig. 1(*d*) is resampled using the bootstrap to construct 95% confidence intervals around the overall method usage proportions.
(2) Which methods complement one another? Pearson product moment correlations between each of the 39 methods are tabulated, resulting in 39×39 correlation matrix. The magnitudes of these correlations are then compared to determine which methods complement one another.
(3) Which methods were used for different kinds of design for development problems? Method usage is segmented across particular focus areas and then compared to individual methods' proportions within a focus area and outside a focus area. This is essentially a large-scale hypothesis testing problem with $9 \times 39 = 351$ statistical tests. A normal *Q–Q* plot and a false-discovery rate (FDR) control algorithm [32] deal with the effect of multiple comparisons and locate methods that occur significantly more frequently in particular kinds of problems.
(4) How does method usage compare between professional designers at IDEO and the rest of the HCD Connect community? Method usage is compared across organizational affiliation (IDEO versus non-IDEO) by calculating 95% confidence intervals using bootstrap resampling.

For further details regarding the methods, one can go to the companion site[8] and download the experiment code to review or reproduce any of the below results.

Results

The analysis of HCD Connect's user research methods contains four parts: Describing general patterns of overall usage, finding methods that complement one another, inferring which methods are more frequently used for particular types of problems, and comparing patterns of method usage between IDEO and non-IDEO community members. In brief, for each part, respectively, the paper finds that: Methods from earlier in the design process that focus on user needs and preferences are more frequently used; that certain methods correlate well with others, primarily within design stages, and to a lesser extent across design stages; that a select few methods are significantly more common for certain types of development problems than they are in general; and that IDEO designers use fewer methods overall than non-IDEO counterparts and tend to focus on earlier design stages.

Method Usage Overall. For the first question, "How does method usage vary across the entire case study corpus?" Figure 2 demonstrates the percentage of cases that contain a particular method. From this, one can immediately discern the prominence of user needs methods in the initial phase of the HCD Toolkit (hear): Members use many of these methods in up to one-quarter to one-third of all cases. As one moves later in the design process, method usage decreases.

In aggregate, hear, create, and deliver methods occurred in the following number of cases (out of 809), respectively: 702 (87%), 440 (54%), and 272 (34%). This represents a substantially larger representation of hear methods with respect to the other two categories (see Fig. 6 for 95% confidence interval estimates around the percentages).

Finding Complementary Methods. For the second question, "Which methods complement one another"? Figure 3 visualizes the Pearson product moment correlation coefficients between each pair of methods across all cases; this correlation ranges between 1 (always used together) and −1 (never used together). Notably, there are no cases of strong negative correlation; methods were either positively correlated or uncorrelated. The figure groups the rows and columns such that methods in similar design stages remain together.

To explore these correlations further, this section considers two sets of data. First, it looks at correlations across all 809 case studies, regardless of which methods they use; this provides an overall picture of the full corpus and assumes all case studies are equally valuable. Second, it restricts the corpus to only those case studies that use methods from across all three phases ("hear," "create," and "deliver"); this restricted corpus provides a different interpretation of how methods are related by studying only case studies that covered the entire process.

Method Comparisons Across Entire Corpus. To highlight which methods are most complementary to one another, Table 2 rank orders the top 20 method pairs by correlation coefficient—i.e., they are the 20 methods most likely to co-occur together. (A full ranked list of all correlations can be downloaded from the paper's companion website.[9]) This approach locates many pairs of methods one would expect to be complementary. For example, the methods individual interview, group interview, expert interview, interview guide, and interview techniques all highly correlate with one another—they all leverage a type of interviewing. Highly visual methods that involve drawing abstractions or clustering also highly correlate with each other: Create framework, diagrams, storyboards, find themes, and extract key insights from user research. Methods concerned with assessing the end result of the process correlated together: Evaluate outcomes, track indicators, implementation timeline, and the learning loop. Community-centered methods, such as build on the idea and participatory codesign, correlate with one another. The vast majority of the top-ranked correlations have methods from the same design stage; this is expected, since methods from the same stage would have a higher likelihood of being used together, as well as being more similar to each other in goal (thus having multiple activities, like interviewing, constitute several possible methods).

The above results view correlation as a proxy measure for either complementary (positive correlation) or substitution (negative correlation), and one would expect to find both types of effects among

[8] http://ideal.umd.edu/hcdconnect

[9] http://ideal.umd.edu/hcdconnect

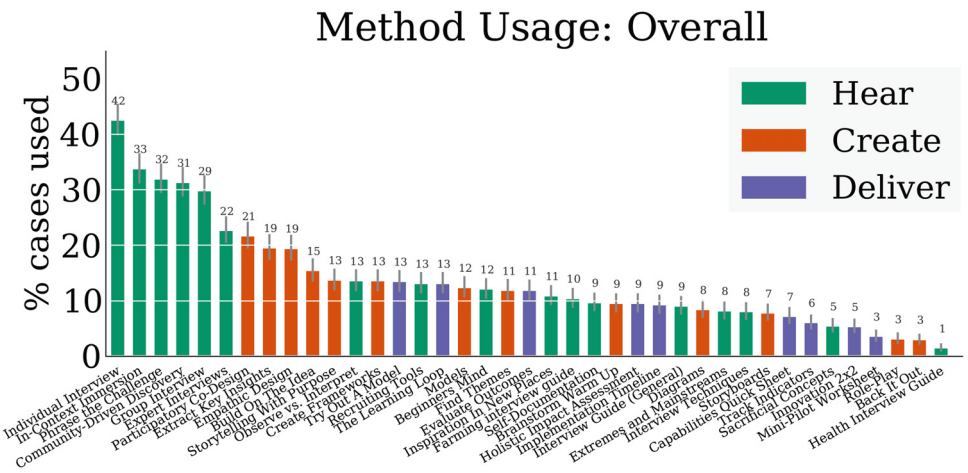

Fig. 2 Percent method usage by case. Overall, users use methods from earlier design stages more frequently.

various design methods. Unexpectedly, however, almost no methods were substitutes for one another. One possible explanation for this is that while, in general, design methods can be substitutes for one another, IDEO selected particular methods for their HCD Toolkit that were purposefully diverse and complementary, rather than substitutes. One would expect substitution effects to occur in larger databases of design methods (e.g., see Ref. [8]) where selection bias is less likely.

One possible caveat to the above results is that certain cases may only focus on certain stages, and thus the correlations could be biased toward correlations within each stage. For example, if a certain project only covered the beginning of the design process (e.g., the hear stage), then certain methods in later stages may not correlate as frequently as they would in case studies that cover all design stages. The next three paragraphs address this caveat by restricting the corpus so that it only contains cases that used at least one method from each of the three design stages.

Method Comparisons Across Cases That Use All Stages. Restricting Restricting the corpus to only those cases that use methods in all three stages (218 of the 809 cases), Table 3 rank orders the top 20 method pairs by correlation coefficient (similarly to Table 2), while Fig. 4 visualizes the correlation coefficients (similarly to Fig. 3). Tables 2 and 3 share not only many similarities but also important differences. In terms of similarities, they both continue to highlight strong correlations for certain within-stage methods. For example, the previous clusters of interviewing methods (e.g., individual interview, group interview, etc.) and visual methods (e.g., frameworks, diagrams, etc.) remain.

In terms of differences, methods now correlate more by how the method is used than by the stage it is used in.[10] In Table 2, many visual methods from the create stage correlated together, whereas in Table 3 they also correlate with visual methods from different stages. For example, frameworks (create stage) and innovation 2×2s (deliver stage) are highly correlated. Likewise, community-driven discovery (hear stage) and participatory codesign (create stage) both heavily involve community participation; they occur as highly correlated in Table 3 but not in Table 2.

The comparison between Tables 2 and 3 highlights an important assumption about the above correlation analysis: Segmenting corpora will affect the kind of correlations one can expect to find. In Table 2 and Fig. 3, the clusters and correlations uncovered temporal variation, despite the algorithms having no knowledge of the design stages. When the corpus is segmented to remove this temporal variation, factors relating to the context of the method (e.g., visual methods) emerge instead. When applying this kind of technique to new domains, the purpose of the desired correlations and clusters should drive the choice of corpus segmentation. In essence, the kind of problem one wishes to solve (e.g., dividing methods by time, or how they are used, or by user group, etc.) necessarily affects how one collects and segments the data.

Differences in Method Usage Across Focus Areas. To answer the third research question, "Which methods were used for different kinds of design for development problems?" One can partition the case studies by focus area (Table 1), and then compute independent sample t-statistics for each method's usage frequency in a focus area (comparing the results with each method's usage frequency across all other focus areas). Testing all these combinations results in 351 different statistical comparisons, and Fig. 5 plots these t-statistics as a probability plot, where it shows that most of the comparisons result in no appreciable difference (the straight line). However, toward the right and left sides, a few comparisons stand out as unexpected.

Quantitatively, one can account for these multiple comparisons by using the Benjamini–Hochberg (BH) procedure [32], assuming independent tests with an FDR of 5%. The BH procedure is a Bonferroni-like post hoc correction to the results of multiple statistical tests; its principle advantage being that it allows one to directly control the FDR—essentially type-I error, but across multiple tests. With this, one can filter down the comparisons in Fig. 5 to the reduced list in Table 4. This table orders each method and focus area by the probability of the observed t-statistic, while also providing the percentage difference in frequency (%Δ—essentially the percentage effect size). A full list of all 351 tests is available on the paper's companion website.

The results indicate that several methods had sizable differences in percent usage depending on the focus area: In agriculture—farming interview guide (+16%) and try out a model (+11%); in community development—participatory codesign (+15%) and community-driven discovery (+14%); and in gender equity—group interview (+17%). Many of the selected pairs are expected; for example, the algorithm correctly identifies that the farming interview guide is appropriate for agriculture problems, even though the algorithm did not have prior knowledge about what agriculture means. This provides a data-driven means of identifying which design methods are uniquely suited to problems in a particular focus area.

An important point to emphasize here is that the correlations between methods and focus areas represent methods that are more frequently used for a particular focus area over other focus areas.

[10]For example, the difference between intra- and inter-stage correlations is +0.04 for the full 809 cases, but reduces to −0.03 when one analyzes only cases that use methods from all phases. This difference is confirmed via statistical permutation tests (with $p \approx 0.0054$ and $p \approx 0.99$, respectively) available via the paper's supplemental research code.

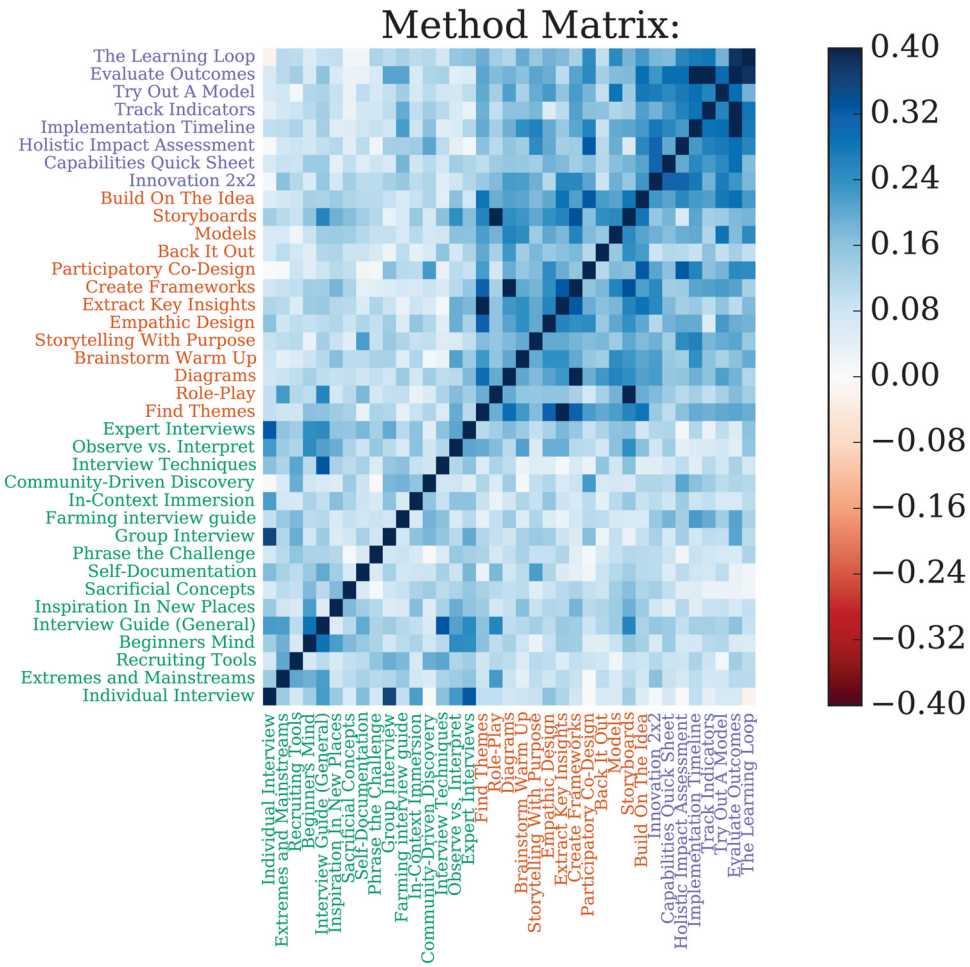

Fig. 3 Over every case, certain methods more positively correlate with other methods with almost no negative correlation between methods. The shaded boxes indicate the correlation coefficient between methods—darker indicates increasing positive correlation. The diagonal is thresholded to 0.4 for clarity of presentation, since it always has correlation of one. Methods from later stages (create and deliver) have higher correlation within each category, as well as across categories. Deliver, Create, and Hear methods are clustered together in that order from top to bottom [10,33].

This frequency is a product of both the methods' applicability as well as a particular user's preferences for that method in a particular focus area. For example, the fact that "farming interview guide" is highly correlated with "agriculture" could be because that method is well-suited for that type of problem, or because users simply feel more familiar with that method in that context. As such, these results assume that users are not simply picking methods at random or solely by familiarity, but that methods are, at least in part, chosen based on their expected utility for the problem at hand.

Differences Between IDEO and Non-IDEO Users. For the last question, "How does method usage compare between professional designers at IDEO and the rest of the HCD Connect community?" This section compares the method usage behavior between IDEO and non-IDEO affiliated users. This affiliation is a proxy for a particular design culture, since there was no straightforward way to separate out professional designers and nonprofessional designers from the non-IDEO user pool.

Figure 6 demonstrates the differences in how IDEO and non-IDEO members report methods. In the IDEO case, the designers place heavy emphasis on earlier stage (hear) methods for user needs and preferences, with method usage dropping off rapidly in later stages. Moreover, those designers do not report many case studies where they used methods from multiple stages (e.g., hear+create). This is in part due to the low percentages of create or deliver methods in general, but also could be due to different reporting styles—IDEO designers could systematically split their cases into multiple case studies over different stages, rather than a single case, or they could only be hired for projects in the hear stage of development. Another possible explanation could be that IDEO's culture or the particular structure of their toolkit creates an unstated preference or emphasis on earlier stage methods, or possibly that members selectively report cases they believe would fit that culture.

Comparing individual methods, Fig. 7 confirms Fig. 6: IDEO users use fewer methods overall, but have a much higher percentage usage in the initial hear stage, rather than in the create or deliver stage. In addition, Fig. 7 demonstrates that IDEO designers prefer certain types of methods for each phase, compared to non-IDEO designers who use more of a mix. For example, IDEO designers appear to prefer methods that involve data interpretation, such as extracting insights and themes, building frameworks and models, etc. (many of those methods complement each other as per Table 2). Since this data involves only self-reported method usage from after a completed design process, there is potential for self-selection: Observed differences between groups might be caused not only by differences in behavior but also by differences in what methods or projects an individual chooses to report. Also,

Table 2 The 20 highest correlated methods from Fig. 3; these methods likely complement each other ($N = 809$). The method's design stage within the HCD Connect toolkit is shown in parentheses ("H," "C," and "D" for hear, create, and deliver, respectively.

Corr.	Method 1	Method 2
0.46	(D) Evaluate outcomes	(D) Track indicators
0.42	(C) Find themes	(C) Extract key insights
0.41	(C) Storyboards	(C) Role-play
0.41	(C) Create frameworks	(C) Diagrams
0.40	(D) Evaluate outcomes	(D) Implementation timeline
0.38	(D) The learning loop	(D) Evaluate outcomes
0.36	(H) Individual interview	(H) Group interview
0.34	(C) Create frameworks	(C) Storyboards
0.33	(H) Interview techniques	(H) Interview guide
0.33	(C) Create frameworks	(C) Extract key insights
0.33	(C) Build on the idea	(C) Participatory codesign
0.33	(H) Individual interview	(H) Expert interviews
0.33	(C) Participatory codesign	(D) Holistic impact assessment
0.32	(C) Find themes	(C) Create frameworks
0.32	(C) Find themes	(C) Empathic design
0.31	(D) Capabilities quicksheet	(D) Innovation 2×2
0.31	(D) Innovation 2×2	(D) Holistic impact assessment
0.30	(D) Try out a model	(D) Evaluate outcomes
0.30	(C) Find themes	(C) Diagrams
0.29	(C) Build on the idea	(D) Evaluate outcomes

IDEO could be hired to perform more projects that use methods from the hear stage, leading to the differences observed in Fig. 7.

Conclusions and Future Research

This paper demonstrates how to apply statistical techniques to analyze how designers employ user research methods in developing-world contexts. Specifically, the focus is on the HCD Toolkit—a set of methods used by IDEO.org—and how those methods are used across a variety of factors: What stage of design is most frequent; what methods are commonly used together; what methods are frequently used for certain types of problems (agriculture, health, etc.); and how does method usage differ across affiliations (IDEO versus non-IDEO). The techniques assume that the methods and cases reported by users were based, at least partially, on the method's expected utility and not solely on random guessing or familiarity.

Table 3 The 20 highest correlated methods from Fig. 3, when filtered by cases that use methods from across all phases ($N = 218$). The method's design stage within the HCD Connect toolkit is shown in parentheses (H, C, and D for hear, create, and deliver, respectively.

Corr.	Method 1	Method 2
0.45	(H) Interview guide (general)	(C) Role-play
0.43	(C) Storyboards	(H) Interview guide (general)
0.43	(C) Storyboards	(C) Role-play
0.37	(C) Create frameworks	(C) Diagrams
0.37	(H) Interview techniques	(H) Interview guide (general)
0.37	(H) Extremes and mainstreams	(C) Role-play
0.33	(C) Models	(H) Expert interviews
0.32	(D) Evaluate outcomes	(D) Track indicators
0.32	(D) Innovation 2×2	(H) Extremes and mainstreams
0.32	(H) Group interview	(D) Evaluate outcomes
0.31	(H) Individual interview	(H) Expert interviews
0.31	(H) Interview guide (general)	(H) Extremes and mainstreams
0.31	(C) Create frameworks	(D) Innovation 2×2
0.30	(H) Community-driven discovery	(C) Participatory codesign
0.30	(C) Extract key insights	(D) Innovation 2×2
0.30	(H) Interview techniques	(C) Storyboards
0.30	(H) Individual interview	(H) Group interview
0.29	(D) Capabilities quick sheet	(H) Beginners mind
0.29	(H) Individual interview	(C) Empathic design
0.29	(C) Models	(D) Try out a model

The findings have several implications on the application of design thinking and user research to design for development projects: Focus on earlier stage design methods, determine whether a particular problem requires a specific type of method before diving in, and equip oneself with complementary methods.

As Figs. 2, 6, and 7 demonstrate, members of HCD Connect use a higher percentage of earlier stage design methods. Part of this reason could be that IDEO's culture or the particular structure of their toolkit creates an unstated preference or emphasis on earlier stage methods, or possibly that members selectively report cases they believe would fit that culture. That said, one outcome remains clear: An integral part of almost all cases involved using methods that allow the designer to understand the user needs and preferences in the community one is designing for. Regardless of its cause, this HCD tenant is particularly critical for developing-world contexts, where the end-user's experience of the product or service will often be substantially different from that of the designer. The authors are currently investigating broader classes of methods and cases from outside HCD Connect to examine this pattern of usage.

Figure 5 and Table 4 demonstrated that certain methods work well in particular problem types; the difficult piece being how to identify those particular cases. An approach based on multiple comparison testings with FDR control procedures is recommended, though other options exist for possible future research directions. Part of the difficulty lies in determining an appropriate minimum effect size: Is a 17% increase in a method's usage important enough? At what threshold is a focus area's effect on a method too large to ignore? It is also notable that many methods *did not* differ among problem types—this points to a dichotomy between general-purpose methods and problem specific methods. Some research has begun to map out these differences [8], but more in-depth quantitative and qualitative work is needed.

Finally, in Fig. 3 and Table 2, it can be seen that all methods are not independent from one another. Understanding how methods relate to one another, whether by automatic means (such as correlation coefficients) or through qualitative study, would allow a designer to make more strategic method choices. For example, if one knows that storyboards better complement role-play over group interviews designers can make smarter user research choices and tradeoff breath for depth.

Note that this paper focuses on a statistical analysis of the application of user needs research in HCD Connect, but does not discuss the efficacy of the methods, except to highlight differences in usage between experienced IDEO designers and non-IDEO designers. Working with professional designers, ISO standards have been developed for conducting HCD in ISO 9241-210 for interactive systems [34]. These standards highlight "best practices" but do not recommend specific methods nor do they contextualize for developing-world applications. They do not include a cost-effectiveness analysis, as was done by Griffin and Hauser [35], for example, in contrasting the percentage of needs identified through use of focus groups versus one-on-one interviews.

The authors of this paper are conducting complementary research on design for development that address efficacy and contextual issues associated with obtaining user needs and preferences in design for development. Gordon et al. [36] evaluated the use of relevant aspects of ISO 9241-210 to find correlations with HCD processes and success in winning sponsor selection for further development using design challenges from the OpenIDEO platform. They found that all used some kind of HCD method to obtain user needs, but found no correlation of a particular method with success. They did find a correlation with the number of inspirations and ideas generated, along with the elicitation of feedback on early prototypes, however. Vechakul and Agogino [31]

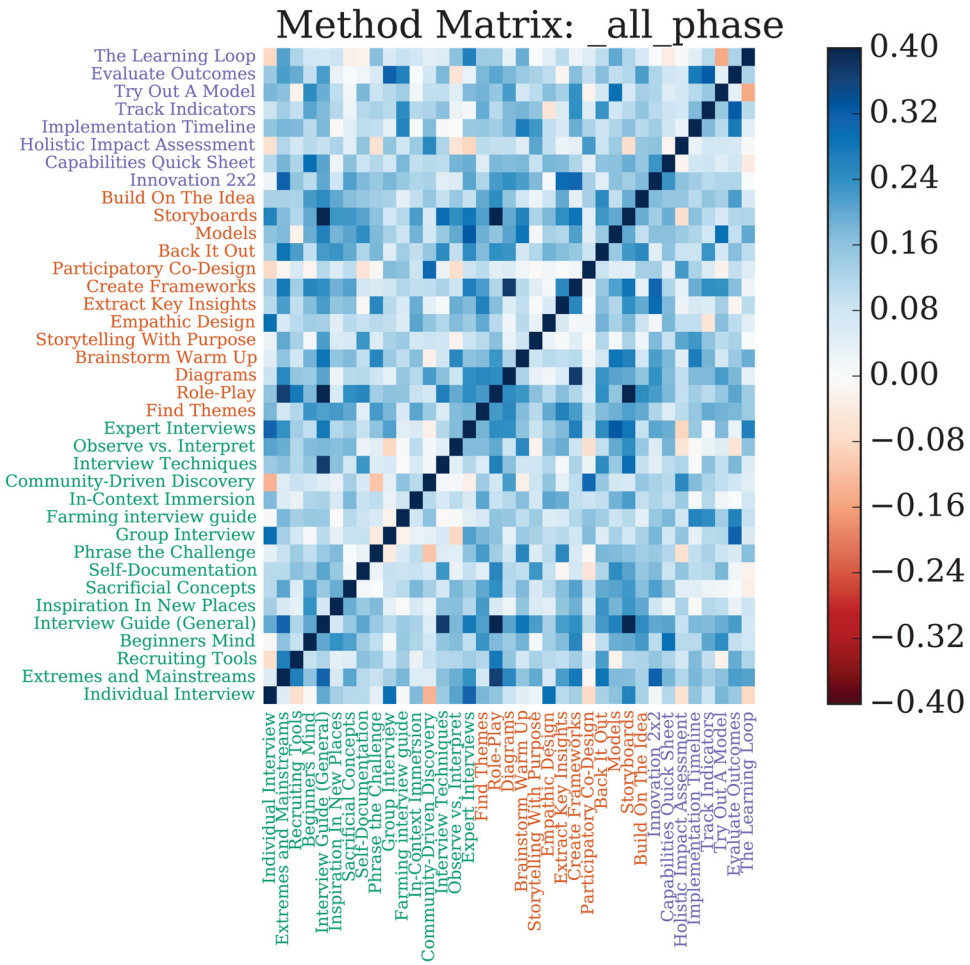

Fig. 4 By restricting the cases to only those that used methods across all cases, one can remove certain temporal relationships between methods

characterized and evaluated the contextual strengths of methods used by IDDS let by MIT with methods used by IDEO.org. Further content analyses of these case studies could elaborate why specific methods were chosen, along with what worked well or poorly.

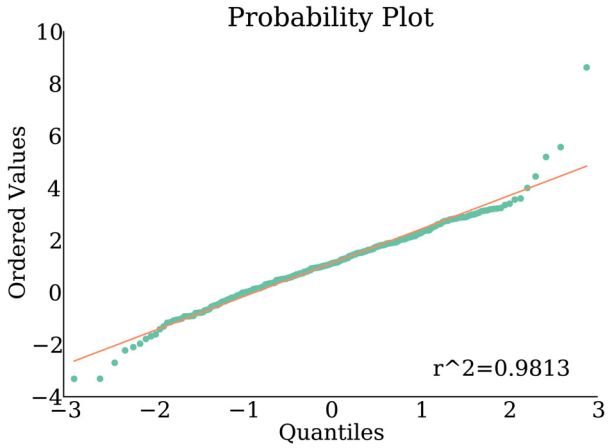

Fig. 5 A normal probability plot for focus area method *t*-statistics. Most methods in each focus area are not appreciably difference from their usage overall; however, for selected methods on the left and right hand side, their usage patterns differ from other focus areas. Table 4 lists the methods, whose usage differs across particular focus areas.

Another helpful next step would be to establish a better qualitative understanding about why certain methods were chosen for particular types of problems (e.g., farming interview guide for agriculture versus participatory codesign for community development). In the same vein, exploring how IDEO or non-IDEO designers choose the methods they use, given the problem context, would enlighten many aspects of this paper. Part of the future work includes using a wider set of methods and cases from the DesignExchange [8,9] to broaden the analysis outside of design for development methods.

The techniques and results presented here apply to design for development projects using user research methods, however a natural question arises: To what extent could they extend to other types of projects or methods? Comparisons with methods and cases from a broader set of design areas are a necessary next area of research, and researchers are presently collecting such databases that would allow for such comparisons [8,9]. Once collected, the statistical techniques used to analyze user research methods in this paper could also be used to analyze usage in a broader class of methods. In nondevelopment projects, it is expected that user research methods would also focus on earlier stages of design and that correlations such as those in Tables 2 and 3 would not differ drastically; however, usage of data from a variety of domains would be necessary to confirm that claim.

With both a quantitative and qualitative picture of how user research methods are applied in design for development projects,

Table 4 Methods whose usage in a given focus area is significantly different from all other focus areas. The first column lists the probability of the observed *t*-statistic, the second lists the difference between the usage percentage of that method in that focus area with respect to other focus areas, the third column lists the method, and the fourth lists the particular focus area in which method usage was different. These methods were selected from those in Fig. 5 using the BH procedure at an FDR of 5% assuming independent or positively correlated tests.

Prob.	% Δ	Method	Focus areas
5.8×10^{-17}	15.7	Farming interview guide	Agriculture
3.4×10^{-8}	15.3	Participatory codesign	Community development
2.6×10^{-07}	11.6	Try out a model	Agriculture
1.0×10^{-05}	14.3	Community-driven discovery	Community development
6.8×10^{-05}	4.7	Minipilot worksheet	Agriculture
3.6×10^{-04}	8.7	Holistic impact assessment	Environment
4.9×10^{-04}	17.1	Group interview	Gender equity
7.2×10^{-04}	8.9	Storytelling with purpose	Education
8.4×10^{-04}	5.3	Track indicators	Agriculture
1.1×10^{-03}	−11.1	Expert interviews	Water
1.1×10^{-03}	−14.4	Individual interview	Water
1.3×10^{-03}	8.0	Build on the idea	Community development
1.5×10^{-03}	7.9	Farming interview guide	Environment
1.6×10^{-03}	13.2	Storytelling with purpose	Gender equity
1.7×10^{-03}	15.3	Community-driven discovery	Gender equity
1.8×10^{-03}	7.4	Storytelling with purpose	Community development
2.1×10^{-03}	4.5	Health interview guide	Health
2.1×10^{-03}	17.3	Community-driven discovery	Financial services
2.3×10^{-03}	4.6	Innovation 2×2	Agriculture
2.6×10^{-03}	7.8	Evaluate outcomes	Environment
2.9×10^{-03}	5.9	Holistic impact assessment	Community development

one can be better equipped to make the right resource decisions when embarking on design for development projects, allowing us to create better products and services by making sure that designs address the correct user needs.

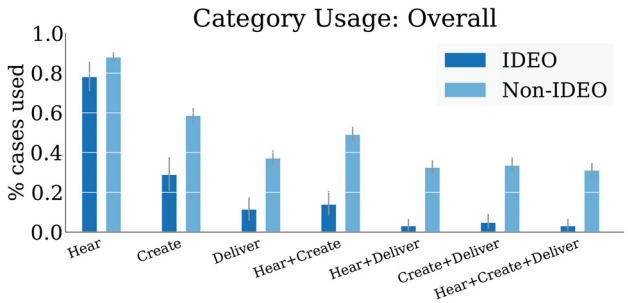

Fig. 6 Method usage grouped by organizational affiliation. Combined columns, such as "hear+create," indicate cases where at least one method from each category was used in the case. IDEO members contribute case studies that typically focus on the first design stage (hear), and rarely submit cases that combine methods across different design stages. In contrast, non-IDEO members contribute cases that use a more even distribution of methods from different design stages, and typically combine methods from different stages in a single case study. The error bars around the percentage estimates represent 95% confidence intervals calculated through bootstrap resampling.

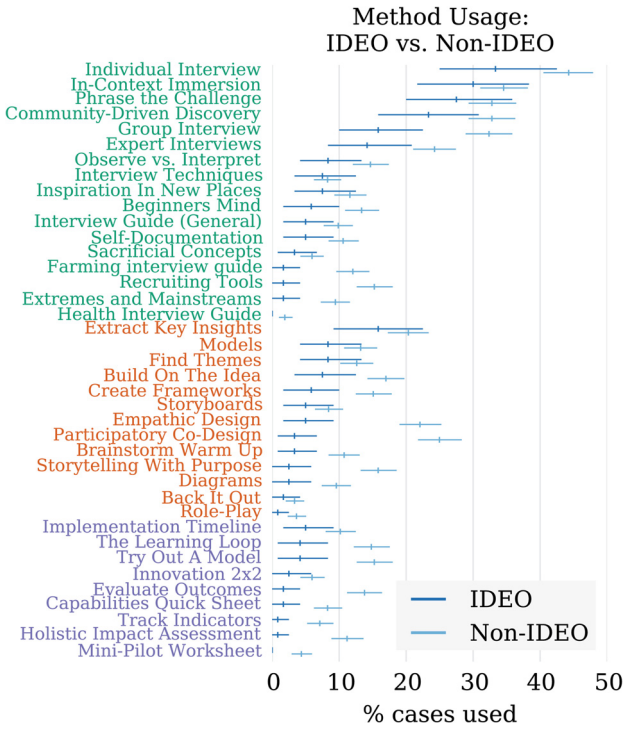

Fig. 7 Differences in particular method usage between IDEO and non-IDEO members. The methods are grouped by green, orange, and purple for hear, create, and deliver, respectively. As noted in Fig. 6, IDEO members tend to use fewer methods per case overall, and particularly focus on the first design stage (hear) on user needs and preferences. The bars represent 95% confidence intervals around the usage percentage, created using bootstrap resampling.

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