



## A comprehensive value framework for design

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### ARTICLE INFO

#### Keywords:

Interdisciplinarity  
Design studies  
Human values  
Value framework  
Empirical research  
Cluster analysis

### ABSTRACT

The significance of human values in everyday life highlights the integral role of this concept in any design that aims to improve the quality of human life. By emphasizing the need for a comprehensive value framework for design, the present study explores a new value framework to be used as a common ground in design. For this purpose, we empirically investigate how different people group human values. By spreading the link of our Human Values Survey worldwide via the internet, a variety of participants with different cultural backgrounds were reached, and hierarchical cluster analysis was used to analyze the data. As a result, 568 complete answers were collected, from which nine value groups were concluded: “carefulness”, “justice”, “ecology”, “respect for others”, “meaningfulness”, “status”, “pleasure”, “respect for oneself” and “personal development”. After clustering our data, we propose a value framework with four themes, nine value groups, 42 key values, and 135 extra values. This framework, raising designers’ awareness and widening their view of human values, provides the opportunity to address a diverse range of human values in design.

Nowadays, life without technology is hardly imaginable. In this era, technology is interwoven with all aspects of life, and people perceive the world via technological artifacts [1]. As technological artifacts are not self-formed phenomena, emphasizing their role in a human’s life brings the responsibility of designers to light [1,2]. As this debate has increasingly drawn attention in recent decades [3,4], several scholars have focused on the ethical qualities of the design process (e.g., Refs. [5–10]) and designed artifacts (e.g., Refs. [11–16]).

Nevertheless, while design in its origin aims “at changing existing situations into preferred ones” [17,p.111], there is very little agreement on what a preferred/better situation means and how it is to be achieved. In this respect, human values can be introduced as the touchstone. According to Rokeach [18,p.5], value is “an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence”. Human values guide human actions and behavior in daily situations. They give expression to basic human needs. Values have a strong motivational component because they refer to desirable goals. Values serve as standards and criteria, and value systems are general plans employed to resolve conflicts and to make decisions. Indeed, the

employment of values as standards is a fundamental difference between being human and nonhuman [18], pp. 3–25).

These facts about human values and their functions show that human values are very relevant to design, and even play an integral role in the design process [18]. On the one hand, whenever we talk about basic needs, goals, motivations, actions and behavior, decision-making, or the culture of human beings, we are pointing to concepts that are formed and/or influenced by human values. On the other hand, products have meanings that convey the human values behind their functions [19]. In fact, values can be embedded in products and services [20], and the values expressed by the designer should be interpreted by the user [18]. We will use these points to argue that considering the human values behind every human action, goal, or decision can provide a wide and sensitive view. This view has great importance for a designer’s understanding of what is preferable to stakeholders and to make appropriate decisions [18].

For many years, human values have played an important role in the inquiries of philosophers, sociologists, psychologists, social psychologists, anthropologists, economists, and even politicians. Although the variety of different professions demonstrates good evidence of the

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<https://doi.org/10.1016/j.techsoc.2020.101302>

Received 15 August 2019; Received in revised form 5 January 2020; Accepted 17 June 2020

Available online 23 June 2020

0160-791X/© 2020 The Authors.

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important role of human values, it is difficult to find the most relevant and applicable research findings in the area of design. The reviewed literature showed that despite the significance of human values in everyday life, and consequently in design, they mostly remain implicit and unarticulated in design projects [21]. Only a few design approaches concentrate on human values and aim to address them in their design. Nonetheless, there is very little agreement between them in terms of identifying values. In this respect, the lack of an established and accepted fundamental grounding [22] and a comprehensive list of values [23] can be considered a major unresolved issue. Accordingly, our research, with the intention of supporting designers to embed human values consciously and explicitly in the design process, aims to provide a comprehensive framework to raise designers' awareness of human values and widen their view of the various types of value in different aspects of life. Such a framework would facilitate specifying human values relevant to a diversity of design projects.

## 1. Human values in design

Searching for values in design, we distinguish between value as "The quality of being useful and important" and value as "What is important for people in life" [24]. In our study, we focus on the second definition, which is about human values, rather than the first, which is about the value of an object. To investigate human values in design, we reviewed the design approaches that aim to address human values in design. In this respect, we found only three independent design approaches that aim at addressing human values in design: value sensitive design (VSD) [25], value-led participatory design (VPD) [26], and value-centered design (VCD) [27]. Moreover, two institutes, Values in Design (VID) [28] and Delft Design for Values (DDFV) [29], are suites of projects suggesting no independent approach. We found some scholars that applied one of these approaches (e.g., Refs. [30,31]); some scholars that wrote an overview or critique on them (e.g., Ref. [32,33]); some scholars that worked with values in design without following any of those approaches and without establishing a new method (e.g., Ref. [34]); and some scholars that did not follow any of these approaches but applied one of the existing approaches in social sciences (e.g., Ref. [35,36]). We also found some scholars that extended the value list of VSD for the advantage of their own research (e.g., Ref. [37]).

The three independent design approaches (VSD, VPD, and VCD) have different ways of identifying values. VSD, the most cited and best known approach among the related works, uses a pre-defined list of values. This approach is the only one in design that provides a list of values. However, VSD's list is neither complete nor generic. Indeed, according to the authors, this list does not intend to be complete but presents a list of 'frequently implicated values' to suggest values that should be considered in the investigation. In other words, the core concern in VSD is human values with ethical import that are often implicated in system design [25] and are not representative of different types of human values. The two others, VPD [38] and VCD [27], do not use a fixed list, since they argue that each design project is different: VCD "aims to elicit users' values in order to inform design, sometimes referring to pre-existing value taxonomies" [34], p. 246], and VPD insists that values emerge in collaboration with stakeholders. Although the founders of these approaches already know that "the kind of values that emerge depends on how designer orchestrate the design process" [26], p. 95], they do not suggest any method to raise the designer's awareness of human values. In other words, this approach is valid only if the designer has a sufficient understanding of the concept of human value and has a broad perspective on its various dimensions.

Regarding this, the lack of a comprehensive list of values [23] can be considered a major shortcoming. Since the term 'value' is widely used for different purposes in various disciplines, we need a comprehensive list of values to raise designers' awareness and remind them about the diversity of human values even if they do not value them personally. In this respect, a holistic view of the values of different aspects of human

life is important for design, since improving the quality of human life is the aim of design, and this improvement is related to progress in all aspects of life [39]. Even critical and speculative design uses design to address challenges and opportunities of the future to find and define the most desirable future [40].

In our study, to simplify the understanding and use of the concept of human values, we avoid using the extra adjectives (e.g., internal, external, instrumental, terminal, personal, social, and cultural) for human values that are used in the relevant literature. Instead, we simply use "value item" to refer to a single human value, and "value group" to refer to a set of human values. Also, we use "type of value" to speak about the particular quality that a group of values shares (e.g., recognizing different types of value based on various aspects of human life or different motivations behind the values).

### 1.1. A value framework for design

A framework is "a basic structure underlying a system, concept, or text" [24]. More precisely, a conceptual framework "explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them" [41], p. 18]. By this definition, a value framework is an underlying structure of the concept of human values that presents the concept with categories and clarifies their interrelations to facilitate understanding and working with them. Reviewing a large amount of literature on this topic clarified some significant criteria for such a framework, as follows.

- **Comprehensive:** covers all types of human values and different aspects/dimensions of human life, and is capable of being used in different parts of design for various purposes and diverse topics. This means we need a diverse list that includes various types of human values and is not limited to basic or universal values [42]. In addition, such a framework should not be specified for a design area [43] or for a specific value group(s) [44].
- **Well-classified:** layered meaningfully into different stages. This structure, by clustering value items into 'value groups', introduces different types of human value and shortens the long value list. The value grouping layout is the main skeleton of the framework. In addition, by defining general themes outside the value groups and key values inside them, the framework simplifies understanding, remembering and using the value items, and clarifies the relationships between them [45].

### 1.2. The social science literature on human values

To find a comprehensive and well-classified value framework for design, we reviewed the existing lists of human values produced by different scholars over the last century in the social sciences. Indeed, due to the importance of values in human life throughout history, there have been hundreds of articles published on this topic by scholars from a wide variety of disciplines. Consequently, the focus of our study was limited to a selection of disciplines and a specific time period. This overview framed the main human values studies with the keyword "value" in philosophy, sociology, psychology, and social psychology from 1890 up to 2004.<sup>1</sup> Also, the study was limited to published contributions in English in books, journal articles, and conference proceedings. According to the frameworks and concepts obtained from the related literature, 22 relevant value studies are compiled, of which 13 note a list of values in

<sup>1</sup> In this overview, studies that do not have a generic approach and are specified for a special goal are excluded. For instance, value sensitive design (VSD) [25], which focuses only on moral values relevant to the system design, and list of values (LOV) [98], which is specified for customers in business management, are not included.

their theories or surveys (for an extensive review see Ref. [46]). Table 1 presents all 13 scholars' names, their disciplines, and their lists of values.

As a result of this literature review, we realized that there are some similarities between the different lists.

Weber [47], Scheler [48], Spranger [49], Perry [50], Allport et al. [51], Morris [52], and Kluckhohn and Strodtbeck [53] focus only on types of values without any detail. Indeed, the words mentioned by these scholars as human values represent different groups of values such as social, political, economic, aesthetic, and scientific rather than single value items. These lists are rather short, between five and 13 items.

Maslow [54], Scott [55], Williams [56], and Rokeach [57], in contrast with the previous group, only mention value items (between 12 and 36 items) without any grouping structure. Rokeach recognizes instrumental (mode of conduct) and terminal (end-state of existence) values.

Schwartz [42] and Peterson and Seligman [58] provide lists of value items in value groups. Since their suggested lists are rather long, they structure the lists by clustering the value items. Schwartz introduces 56 value items in ten value groups, and Peterson et al. mention 24 value items in six value groups.

Of these 13 different value lists, Schwartz's value framework is one of the most recent and popular models that is cited widely in different disciplines, including many current practical studies such as marketing and design (e.g., Ref. [35,59,60]).

Although Schwartz's model seems complete regarding value items, on the level of value groups it does not cover all aspects of human life. For instance, "spirituality" is excluded as an aspect/group in his model and exists only as a single value item, one of 56. Schwartz excluded "spirituality" from the value groups because, as he argued:

The idea that spiritual values are a universal type raises two problems. First, the pursuit of meaning and coherence as described by theologians and philosophers may entail a level of sophisticated, effortful thought that is beyond that in which most people typically engage. Instead, most people may satisfy their need for coherence through pursuing tradition, security, and conformity values. Thus, spirituality values may not serve as guiding principles for all people. Second, it is most likely that spirituality is represented by different values for different groups. [...] Hence, no particular set of spiritual values may be universally distinctive, even if a general spirituality type of value is universal [42], p. 10].

Although Schwartz's argumentation may be valid for creating a universal model, we argue that from a design point of view, covering all aspects is more important, even if different people have different opinions about each aspect/group, because this gives them an opportunity to define themselves without limitations and to discuss the differences. In this case, we considered the model without a spiritual dimension to be not sufficiently comprehensive, since, according to Rokeach, using values as standards is "one way of defining the difference between being human and nonhuman" [57], p. 13]. In addition, spirit is the unique part of human beings that makes us different from material beings [61]. In this light, it can be concluded that spiritual values play a significant role in making us human. Therefore, if being a valuable human matters, paying attention to both material and non-material (spiritual) aspects of human life seems to be necessary, and this is not possible without caring about spiritual values in life [62,63].

More precisely, in design, spirituality has a significant place in creating meaningful products, since "a meaningful aesthetic experience of a product becomes one that connects the user to decisions and processes that are in accord with metaphysical or spiritual precepts" [64], p. 8]. Although secularization means to fade the spiritual dimension of human life [65], many studies have pointed out that interest in spirituality has currently increased in scientific research, and many scientists from various disciplines have recently been interested in the possible

influence(s) of spirituality and found this worthy of investigation [66–71]. In addition, spirituality has been introduced as a solution to many problems we currently face in the world [65,72], and has been addressed and investigated in designs by many designers (e.g., Refs. [72–81]).

Spirituality is briefly defined by the Oxford dictionary as "the quality of being concerned with religion or the human spirit" [82]. However, according to several researches (e.g., Ref. [83–85]), spirituality is used and defined in many diverse ways. For example, in Nasr's [86] opinion, spirituality is a concept related to the non-material and spiritual part of human beings without which a human is just a dead body. In fact, by spirituality, he means searching spiritual life and keeping one's connection with the source, God. On the same lines, Pargament [87] believes that spirituality and religion are close relatives, as both are searching for the sacred (the holy and transcendence) and "spirituality is the heart and soul of religion" [87], p. 13]. On the other hand, even those who hold secular or atheistic views recognize this concept [65]. In these views, the spiritual is no longer the sacred, but is "a reality greater than ourselves, a power or presence that goes beyond the individual person" [71], p. 4], and spirituality is "a search for meaning, for unity, for connectedness, for transcendence, for the highest of human potential" [87], p. 6]. Although this explanation is too short to introduce different opinions about spirituality, it can represent two major perspectives on the concept.

To track spirituality in the lists of human values provided by various scholars during the last century, all relevant values listed by the mentioned scholars are compiled in Table 1, by which comparison between items can be facilitated. In this table, values equal or related to spirituality are underlined. Indeed, this comparison reveals that in the majority of the lists, especially in the first half of the twentieth century, "spirituality" is presented not only as a value item but as a type of value beside other types such as "social", "political", "economic", "aesthetic", and "scientific". Although this trend was not followed by some later scholars such as Maslow, Rokeach, and Schwartz, it has reemerged as "transcendence", one of five core virtues, in the latest list by Peterson and Seligman [58].

In summary, this short review indicates that spirituality, directly or indirectly, is present in most existing lists of human values which have been investigated in the past, not only as an individual value item, but also as a dimension for classifying the relevant value items, and a value model not covering this dimension at the level of value groups can be considered to be not sufficiently comprehensive.

This historical overview also shows that, since we define values as what is important for people in life, grouping human values based on different aspects of life (e.g., social, economic, and moral) makes sense. In contrast, Schwartz uses motivational types of value in grouping them, in a way which is not very common in everyday conversation. In this respect, Dooyeweerd's [88] theory of modal aspects, which focuses on the many aspects of reality, can be helpful for understanding different aspects of human life. He defines an aspect as "a way of looking at something, a way in which things can be meaningful" [89], p. 2]. In his theory, Dooyeweerd introduces 15 different aspects or 'modes of being' that can be distinguished in any object/subject. Of these, nine aspects are about values and norms: (1) analytical, (2) formative, (3) lingual, (4) social, (5) economic, (6) aesthetic, (7) juridical, (8) moral, and (9) faith [88]. Nevertheless, all these aspects are related to one of four general themes of self, others, nature, or beliefs [90].

All in all, amongst the reviewed lists of values with flat or layered frameworks, Schwartz's value model seems more complete in terms of value items, but not regarding value groups, due its exclusion of spirituality from this level. So, although by considering all the reviewed lists we have a comprehensive list of value items, we still need to structure them to create a useful framework. In this respect, grouping value items based on different aspects of life, like the scholars of the early part of the previous century did, makes sense.

**Table 1**  
Lists of values (1900–2004), including the scholars' names, their disciplines, and their lists of values.

| Time    | Scholar  | Discipline | Value list  | Reference |
|---------|--|------------|---|-----------|
| 1905    | Max Weber                                      | SC         | (1) Religion, (2) Economy, (3) Politics, (4) Aesthetics, (5) Erotic, (6) Intellectualism  | [47]      |
| 1913–16 | Max Scheler                                    | PH         | (1) Pleasure, (2) Utility, (3) Life, (4) Culture, (5) Holy  | [48]      |
| 1914    | Eduard Spranger                                | PH, PS     | (1) The theoretical, or interest in discovery of truth; (2) The economic, or interest in usefulness; (3) The aesthetic, or interest in form and harmony; (4) The social, or interest in the love of people; (5) The political, or interest in power; (6) The religious, or desire for comprehension of, and unity with, the cosmos as a whole   | [49]      |
| 1926    | Ralph B. Perry                                 | PH         | (1) Moral, (2) Aesthetic, (3) Scientific, (4) Religious, (5) Economic, (6) Political, (7) Legal, (8) Customary  | [50]      |
| 1931    | Gordon W. Allport et al.                       | PS         | (1) Theoretical, (2) Economic, (3) Aesthetic, (4) Social, (5) Political, (6) Religious  | [51]      |
| 1956    | Charles W. Morris                              | PH         | Way 1: Preserve the best that man has attained<br>Way 2: Cultivate independence of persons and things<br>Way 3: Show sympathetic concern for others<br>Way 4: Experience festivity and solitude in alternation<br>Way 5: Act and enjoy life through group participation<br>Way 6: Constantly master changing conditions<br>Way 7: Integrate action, enjoyment, and contemplation<br>Way 8: Live with wholesome, carefree enjoyment<br>Way 9: Wait in quiet receptivity<br>Way 10: Control the self stoically<br>Way 11: Meditate on the inner life<br>Way 12: Chance adventuresome deeds<br>Way 13: Obey the cosmic purposes  | [52]      |
| 1961    | Florence R. Kluckhohn, & Fred L. Strodtbeck    | AN         | (1) Human nature: What is the basic nature of people? (Good, Evil, Mixture)<br>(2) Man–nature relationship: What is the appropriate relationship to nature? (Subordinate to nature, dominant over nature, harmony with nature)<br>(3) Time sense: How should we best think about time? (Past, Present, Future)<br>(4) Activity: What is the best mode of activity? (Being, Becoming, Doing)<br>(5) Social relations: What is the best form of social organization? (Individual, Collateral, Hierarchical)   | [53]      |
| 1964    | Abraham H. Maslow                              | PS         | (1) Truth, (2) Goodness, (3) Beauty, (4) Wholeness, (4a) Dichotomy transcendence, (5) Aliveness, process, (6) Uniqueness, (7) Perfection, (7a) Necessity, (8) Completion, (9) Justice, (9a) Order, (10) Simplicity, (11) Richness, (12) Effortlessness, (13) Playfulness, (14) Self-sufficiency, (15) Meaningfulness  | [54]      |
| 1965    | William A. Scott                               | PS         | (1) Intellectualism, (2) Kindness, (3) Social skills, (4) Loyalty, (5) Academic achievement, (6) Physical development, (7) Status, (8) Honesty, (9) Religiousness, (10) Self-control, (11) Creativity, (12) Independence  | [55]      |
| 1970    | Robin M. Williams                              | SC         | (1) Achievement and success, (2) Individualism, (3) Activity and work, (4) Efficiency and practicality, (5) Science and rationality, (6) Progress, (7) Material comfort, (8) Equality, (9) Freedom, (10) Democracy, (11) Humanitarianism, (12) Racism and group superiority, (13) Education, (14) Religiosity, (15) Romantic love and monogamy  | [56]      |
| 1973    | Milton Rokeach                                 | SP         | • Terminal values: (1) An exciting life, (2) Pleasure, (3) Mature love, (4) True friendship, (5) Inner harmony, (6) Social recognition, (7) A sense of accomplishment, (8) Family security, (9) National security, (10) Self-respect, (11) Health, (12) A comfortable life, (13) Freedom, (14) Salvation, (15) Equality, (16) Wisdom, (17) A world at peace, (18) A world of beauty<br>• Instrumental values: (19) Ambitious, (20) Broad-minded, (21) Capable, (22) Clean, (23) Cheerful, (24) Courageous, (25) Forgiving, (26) Helpful, (27) Honest, (28) Imaginative, (29) Independent, (30) Intellectual, (31) Logical, (32) Loving, (33) Obedient, (34) Polite, (35) Responsible, (36) Self-controlled  | [57]      |
| 1990    | Shalom H. Schwartz                             | SP         | (1) Power: Social power, Authority, Wealth, Preserving my public image, Social recognition<br>(2) Achievement: Successful, Capable, Ambitious, Influential, Intelligent, Self-respecting<br>(3) Hedonism: Pleasure, Enjoying life<br>(4) Stimulation: Daring, A varied life, An exciting life<br>(5) Self-direction: Creativity, Curiosity, Freedom, Choosing own goals, Independent<br>(6) Universalism: Protecting the environment, A world of beauty, Unity with nature, Broad-minded, Social justice, Wisdom, Equality, A world at peace, Inner harmony<br>(7) Benevolence: Helpful, Honest, Forgiving, Loyal, Responsible, True friendship, A spiritual life, Mature love, Meaning in life<br>(8) Tradition: Devout, Accepting portion in life, Humble, Moderate, Respect for tradition, Detachment<br>(9) Conformity: Politeness, Honoring parents and elders, Obedience, Self-discipline<br>(10) Security: Clean, National security, Social order, Family security, Reciprocity of favors, Healthy, Sense of belonging | [42]      |
| 2004    | Christopher Peterson and Martin E. P. Seligman | PS         | (1). Wisdom and knowledge: Creativity, Curiosity, Open-mindedness, Love of learning, Perspective<br>(2) Courage: Bravery, Persistence, Honesty, Zest<br>(3) Humanity: Love, Kindness, Social intelligence<br>(4) Justice: Teamwork, Fairness, Leadership<br>(5) Temperance: Forgiveness, Modesty, Prudence, Self-regulation<br>(6) Transcendence: Appreciation of beauty and excellence, Gratitude, Hope, Humor, Religiousness  | [58]      |

AN Anthropology
PH Philosophy
PO Political science
PS Psychology
SC Sociology
SP Social psychology

## 2. Developing a value framework

Although none of the reviewed lists (Table 1) satisfies our requirements, they can be used as a starting point towards exploring a new value framework for design, and this is not a new approach. Indeed, several scholars, such as Schwartz [42], report integrating the previous lists of values to create a new model. We therefore decided to create a framework by using the existing lists of values but with a new structure. For the development of this framework, clustering value items into value groups is a way of summarizing the value items and reducing the complexity of the list. In addition, the value groups can show different types of values, simplify the relation of the value items to various aspects of life, and link them to everyday life situations.

Our intention in using the existing lists also seems similar to the approach to creating the meta-inventory of human values of Cheng and Fleischmann [91], which uses 12 value lists to create a new list of 48 values with 16 value groups [91]. Although at first sight this meta-inventory looks very similar to what we are seeking, it does not address our requirements of being comprehensive and well-classified. In fact, Cheng and Fleischmann use inventories from various disciplines, including design, marketing, and the social sciences. This means they compare the value lists that have been specified for different purposes and do not intend to be comprehensive in this respect. In addition, they aggregate the lists based on the similarity of values into 16 value groups, which does not add any value to the main list. Nevertheless, applying a similar approach by using the existing lists seems helpful toward achieving our goal.

### 2.1. Grouping human values

To form the main skeleton of the value framework, we conducted an empirical study first to select relevant human values and then group them.

#### 2.1.1. Methods

**Participants:** The main goal of this study is to understand how different people group human values. For this purpose, a variety of participants with different cultural backgrounds were reached via the internet. The link to our Human Values Survey (HVS) was launched in several mailing lists and social networks worldwide. As a result, over ten months (June 2014–April 2015), 568 complete answers were collected: 45.5% of the participants were male, and 54.5% were female. Approximately 60% of the participants were younger than 35 years. The age variable was defined in nine groups,<sup>2</sup> of which the median of participants' age was the third, 25–34 (IQR<sup>3</sup> = 1). The mode of participants' nationality was American (IQV<sup>4</sup> = 0.862), and the rest of the participants were from 68 other nationalities. In religion, 64.4% of the participants presented themselves as having a religion, and 35.6% were non-religious; the mode was Christianity (IQV = 0.795). More detailed demographic information about the participants is presented in Table 2.

**Tool:** To investigate how different people all over the world select and group human values, we conducted a worldwide online survey, the HVS, which contained three steps. The first two steps were about ranking values; the last step consisted of some general socio-demographic questions.

<sup>2</sup> The age categories: 1: <15, 2: 15–24, 3: 25–34, 4: 35–44, 5: 45–54, 6: 55–64, 7: 65–74, 8: 75–84, 9: 85+.

<sup>3</sup> Inter-quartile range (IQR): the range between the 25th percentile and the 75th percentile [97].

<sup>4</sup> Index of qualitative variation (IQV) =  $K(100^2 - \Sigma \text{Pct}^2) / 100^2(K - 1)$ ;  $K$  is the number of categories in the distribution;  $\Sigma \text{Pct}^2$  is the sum of all squared percentages in the distribution [96].

- o In 'the first step, participants were asked to rank 63 items of human values in order of importance for themselves in their lives. They were asked to drag human values from the top list and drop them into the ranking boxes at the bottom (see Fig. 1). The first rank was the most important values for the participants; the second rank was those of second importance, and so forth. They could give the same rank to two or more values, and they were allowed to ignore values that made no sense to them.
- o In the second step, they were asked to make meaningful groups of the values. They were asked to drag human values from the top list and drop them into the group boxes at the bottom. Each group could have from 1 to 63 values—i.e., each value could be in one group only. In this step, the order of the groups was not important. As in the previous step, they were allowed to ignore those values that made no sense to them.
- o The last step contained seven multiple-choice questions about gender, age, relationship status, education, nationality, country of living, and religion.

**Procedure:** To explore a comprehensive value framework via empirical research, we used Schwartz's list (56 human values adopted from the Schwartz Value Survey) as the basis, since comparing the existing value lists convinced us that this was one of the latest and most cited options, and Schwartz claimed that this list represents all motivational types of value [42]. Indeed, Schwartz's value list is a combination of nouns and adjectives, to distinguish between instrumental values (modes of behavior, phrased as adjectives) and terminal values (end states, phrased as nouns) [42], which we used without change. Additionally, we used the card sorting method [92] to rank values instead of using a psychometric scale (e.g., Likert scale), since this approach gives more freedom to the respondent and has a game-like quality [57].

To evaluate the feasibility of the method, we did a pilot test with ten participants using paper cards. Then we digitalized the survey and distributed it worldwide. For this survey, we used a list with 63 items of human values: 56 items were adopted from the Schwartz Value Survey, and an additional seven values were suggested by the participants in the pilot test, including kindness, generosity, patience, altruism, waste avoidance, chastity, and virtue/piety. This survey was designed only in English, though the participants' English skill level was not part of the test. Our HVS was distributed widely via social media (e.g., LinkedIn, ResearchGate, Facebook, and Google+), mailing lists and discussion groups (e.g., [lists.uua.org](http://lists.uua.org) mailing lists, international students at Eindhoven University of Technology, The Hub Eindhoven for Expats, Reddit), and websites (e.g., Social Psychology Network, Psychological Research on the Net). To achieve a wide range of participants, we tried to share the link to our survey in as many relevant local and international groups, websites, or mailing lists with cultural, social, psychological, and religious interests as possible. From all those links, the survey was started more than 1900 times during the eight months. However, less than one quarter finalized the task. We considered as complete only those answers which reached the last step of the survey (468 answers). So, to find more serious participants, the survey was also distributed via Amazon Mechanical Turk (MTurk), a crowdsourcing internet marketplace, and we paid for the answers (US\$1.25 per answer), from which we received an additional 100 complete answers. In total, therefore, 568 complete questionnaires were analyzed.

In this study, the variables are human values including 56 values from Schwartz's list and seven more values suggested by participants in the pilot test.

### 2.1.2. Results

**2.1.2.1. Ranking values.** A frequency analysis of the data from the first step of the HVS showed that "Healthy" was reported by 28.2% of

**Table 2**

Demographic information on participants: gender, age, religion, relation status, and education vs. continent of nationality.

|                     |                 | Continent of Nationality |       |          |                |                |          | Total |
|---------------------|-----------------|--------------------------|-------|----------|----------------|----------------|----------|-------|
|                     |                 | African                  | Asian | European | North American | South American | Oceanian |       |
| Gender              | Male            | 1.4%                     | 11.5% | 9.6%     | 18.6%          | 3.7%           | 1.2%     | 45.9% |
|                     | Female          | 0.6%                     | 9.8%  | 14.1%    | 26.0%          | 2.5%           | 1.2%     | 54.1% |
| Age                 | Young           | 1.2%                     | 20.8% | 17.5%    | 31.8%          | 4.7%           | 1.4%     | 77.4% |
|                     | Middle age      | 0.4%                     | 0.4%  | 5.7%     | 9.4%           | 1.6%           | 1.0%     | 18.5% |
|                     | Old             | 0.4%                     | 0.2%  | 0.6%     | 2.9%           | 0.0%           | 0.0%     | 4.1%  |
| Religion            | Christianity    | 1.2%                     | 2.3%  | 7.4%     | 24.5%          | 2.3%           | 0.4%     | 38.1% |
|                     | Islam           | 0.2%                     | 9.7%  | 0.4%     | 0.2%           | 0.0%           | 0.0%     | 10.5% |
|                     | Judaism         | 0.0%                     | 0.6%  | 0.0%     | 1.0%           | 0.0%           | 0.0%     | 1.6%  |
|                     | Hinduism        | 0.0%                     | 2.1%  | 0.0%     | 0.0%           | 0.2%           | 0.0%     | 2.3%  |
|                     | Buddhism        | 0.0%                     | 1.6%  | 0.0%     | 0.2%           | 0.4%           | 0.4%     | 2.5%  |
|                     | None            | 0.4%                     | 3.1%  | 13.8%    | 15.0%          | 2.7%           | 1.6%     | 36.5% |
|                     | Other           | 0.2%                     | 1.6%  | 2.3%     | 3.9%           | 0.6%           | 0.0%     | 8.5%  |
| Relationship status | Single          | 0.8%                     | 11.4% | 11.2%    | 25.9%          | 3.7%           | 1.0%     | 54.1% |
|                     | Living together | 0.8%                     | 9.8%  | 12.0%    | 19.2%          | 2.9%           | 1.2%     | 45.9% |
| Education           | None            | 0.0%                     | 0.4%  | 0.0%     | 0.0%           | 0.0%           | 0.0%     | 0.4%  |
|                     | Vocational      | 0.0%                     | 1.0%  | 3.5%     | 18.2%          | 0.4%           | 0.4%     | 23.5% |
|                     | Bachelor's      | 1.0%                     | 5.3%  | 6.3%     | 16.5%          | 1.0%           | 0.4%     | 30.4% |
|                     | Master's        | 0.8%                     | 9.0%  | 7.8%     | 5.7%           | 1.6%           | 1.0%     | 25.9% |
|                     | Doctorate       | 0.0%                     | 5.7%  | 6.3%     | 3.9%           | 3.3%           | 0.6%     | 19.8% |

participants as the most important value. This test demonstrated that “Healthy” (28.2%), “Freedom” (25.5%), “Family security” (21.3%), “Honest” (21.1%), “A spiritual life” (21%), “Meaning in life” (19.5%), “Wisdom” (19%), “Self-respect” (19%), “A world at peace” (18.8%), and “Equality” (16.7%) are the top ten values which, in order, received the highest ranking of the 63 values (see Fig. 2).

2.1.2.2. *Clustering values.* To find the association of different human values based on participants’ value grouping in the second step of the HVS, we made a dissimilarity matrix out of the data and used that for a

hierarchical cluster analysis to make a statistical decision. Fig. 3 shows the results of the hierarchical clustering of the 63 human values. In fact, this statistical method does not suggest any specific number of clusters. According to the literature, the decision on the number of clusters is up to the researcher, who needs to decide which number is appropriate in the given application [93].

The results of this study with hierarchical cluster analysis provided various options for cutting the hierarchy in different levels, which could make various numbers of value groups, from two to sixty-three. However, in this study, based on the reviewed value lists (see Table 1), we considered five value groups as too few and 13 value groups as too many

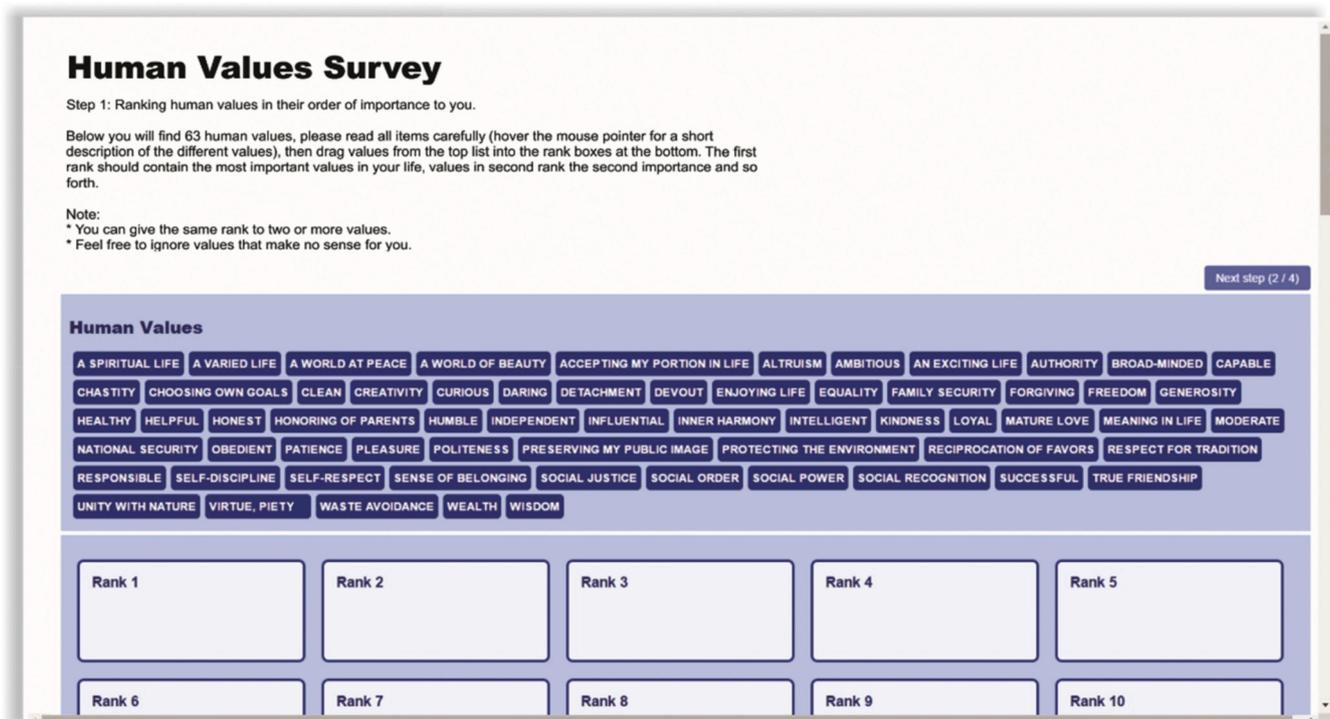


Fig. 1. Interface of Human Values Survey (HVS), the first step.

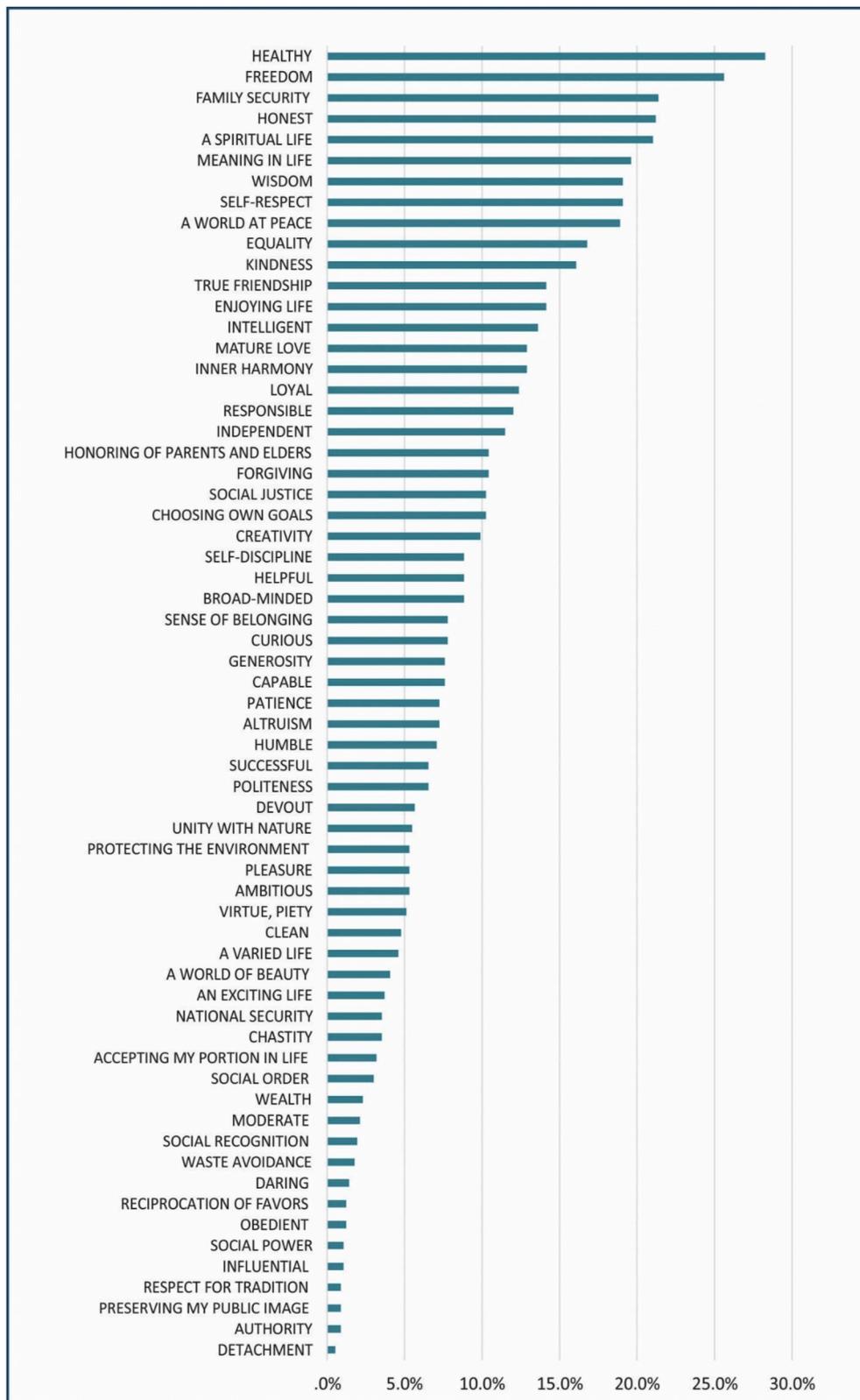


Fig. 2. Frequency of reporting each human value as the highest and most important value.

for our purpose.

In different value lists, the value items are presented in five to 13 groups. Looking at the range of five to 13, the most distinguishable cuts made (A) seven and (B) nine value groups (see Fig. 3). The main difference between these two options is that in the layout with seven value

groups (made by cut A), social values and spiritual values merged and were clustered in the same group. However, in the layout with nine value groups (made by cut B), these two types of values are clearly separated. These two layouts were tested during different design iterations with design students [46].

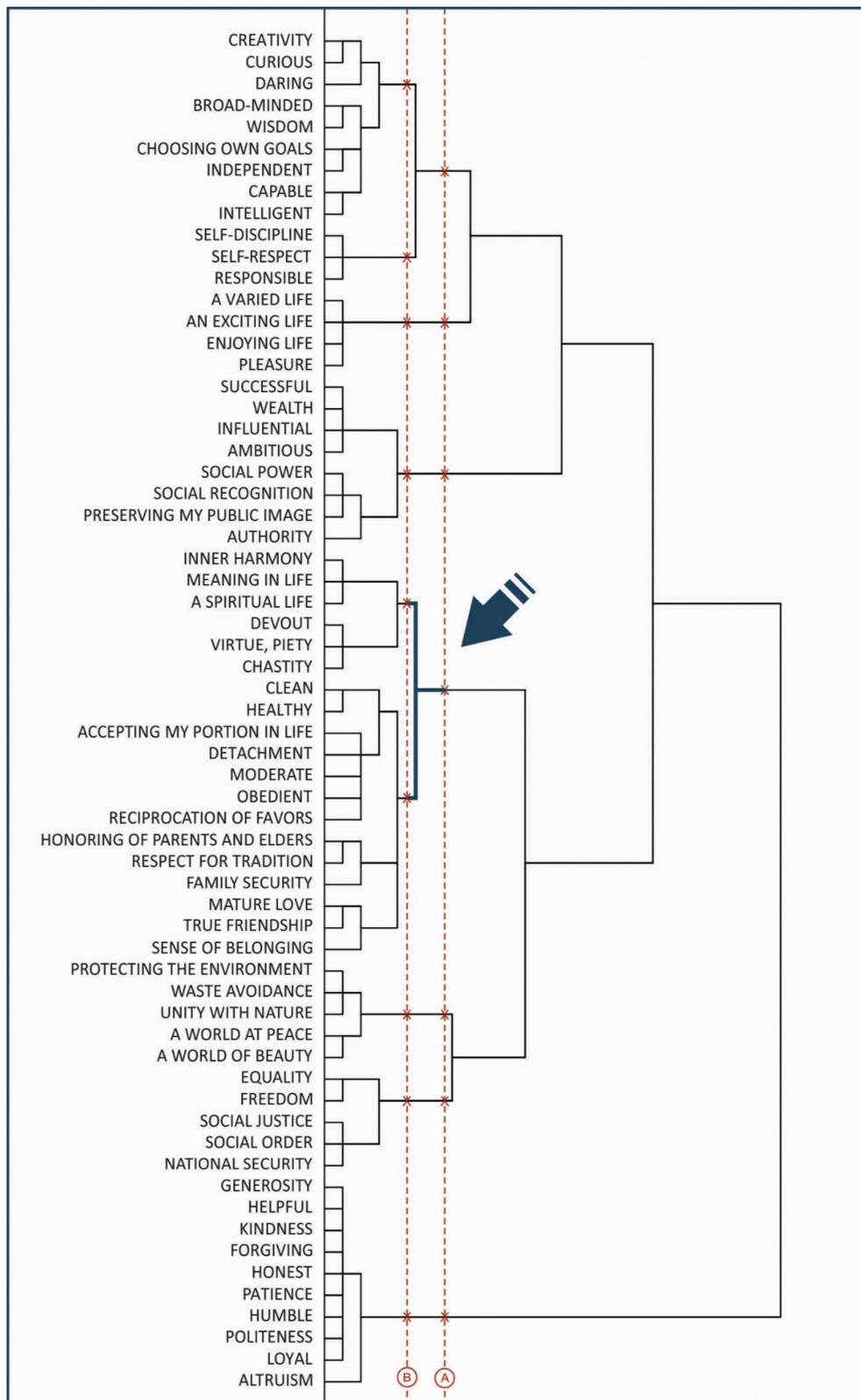


Fig. 3. Results of hierarchical cluster analysis of 63 human values. The most distinguishable cuts make (A) seven and (B) nine value groups. The most important differences between the two cuts are highlighted with green and indicated with an arrow. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

The feedback from the design students indicated that the layout with seven value groups was confusing and they preferred the layout with nine groups, which has two separate groups for social and spiritual values. Also, considering the theory of modal aspects [88], the layout with nine value groups, obtained by putting some value items into the aspect of faith and other value items into the social aspect, covers various aspects of life better than the other layout.

Additionally, the data analysis of ranking values indicated that “A spiritual life” was one of the top ten values for participants worldwide. The importance of this value for the participants, and their placing of the other highly ranked values “Meaning in life” and “Inner harmony” in the same group, convinced us that a separate group for spiritual values is necessary. This demand is supported by many philosophers, such as Weber [47], Dooyeweerd [88], Spranger [49], Allport [51], Scheler [48], and Perry [50].

Accordingly, we found the value grouping layout with nine value groups appropriate for our purpose. These nine value groups are:<sup>5</sup>

- o **Carefulness:** Honest (genuine, sincere), Kindness (cordiality, tenderness), Loyal (faithful to my friends, group), Forgiving (willing to pardon others), Helpful (working for the welfare of others), Generosity (benevolence), Patience, Altruism (selflessness), Humble (modest, self-effacing), Politeness (courtesy, good manners).
- o **Ecology:** A world at peace (free of war and conflict), Unity with nature (fitting into nature), Protecting the environment (preserving nature), A world of beauty (beauty of nature and the arts), Waste avoidance (time, natural sources, opportunities, etc.).
- o **Justice:** Freedom (freedom of action and thought), Equality (equal opportunity for all), Social justice (correcting injustice, care for the weak), National security (protection of my nation from enemies), Social order (stability of society).
- o **Meaningfulness:** A spiritual life (emphasis on spiritual, not material matters), Meaning in life (a purpose in life), Inner harmony (at peace with myself), Devout (holding to religious faith and belief), Virtue, Piety, Chastity (modesty, prudence).
- o **Personal development:** Wisdom (a mature understanding of life), Intelligent (logical, thinking), Independent (self-reliant, self-sufficient), Choosing own goals (selecting own purposes), Creativity (uniqueness, imagination), Broad-minded (tolerant of different ideas and beliefs), Curious (interested in everything, exploring), Capable (competent, effective, efficient), Daring (seeking adventure, risk).
- o **Pleasure:** Enjoying life (enjoying food, sex, leisure, etc.), Gratification of desires, A varied life (filled with challenge, novelty, and change), An exciting life (stimulating experiences).
- o **Respect for oneself:** Self-respect (belief in one’s own worth), Responsible (dependable, reliable), Self-discipline (self-restraint, resistance of temptation).
- o **Respect for others:** Healthy (not being sick physically or mentally), Family security (safety for loved ones), True friendship (close, supportive friends), Honoring parents and elders (showing respect), Mature love (deep emotional and spiritual intimacy), Sense of belonging (feeling that others care about me), Clean (neat, tidy), Accepting my portion in life (submitting to life’s circumstances), Moderate (avoiding extremes of feeling and action), Obedient (dutiful, meeting obligations), Reciprocation of favors (avoidance of indebtedness), Respect for tradition (preservation of time-honored customs), Detachment (from worldly concerns).
- o **Status:** Successful (achieving goals), Ambitious (hardworking, aspiring), Wealth (material possessions, money), Social recognition

(respect, approval by others), Social power (control over others, dominance), Influential (having an impact on people and events), Preserve your public image (protecting my “face”), Authority (the right to lead or command).

We used the results of the ranking of the value items in the empirical research to structure the inside of the value groups by defining five key values in every value group. The number of value items in different groups was unequal, varying from three to 13, and five was the mode. We therefore selected the five highest ranked value items in each group as key values and saved the rest as extra values. Two value groups had fewer value items than five, so we left them as they were; the value group of “Pleasure” has four value items, and “Respect for oneself” has three value items.

## 2.2. Supplementing the structure

The current value grouping layout with nine value groups and key values in each was supplemented by more value items from the existing list of values (Table 1). They were added to cover diverse views. Moreover, according to Berkhof [90], who presents a relational model with reference to human beings, every human being relates to him- or herself, to others, to nature, and to God [90]. Accordingly, we distinguished the relations of the value groups to the four general themes of “Basic beliefs”, “Nature”, “Self”, and “Society”. “Meaningfulness” is about “Basic beliefs”, “Ecology” is about “Nature”, “Respect for oneself”, “Personal development”, and “Pleasure” are related to “Self”, and “Status”, “Justice”, “Carefulness”, and “Respect for others” are related to “Society”. This new layer, like the other layers of this grouping layout, attempts to summarize the value items and reduce the complexity of the list. The structure of the final value framework is presented in Table 3.

## 3. Discussion and conclusion

As discussed earlier, we identified the lack of a suitable value framework for design. To fulfil this need, we developed the value framework with nine value groups, in which each value group is introduced with a descriptive sentence, key values, and some extra values to cover diverse views. The nine groups are “Carefulness”, “Justice”, “Ecology”, “Respect for others”, “Meaningfulness”, “Status”, “Pleasure”, “Respect for oneself”, and “Personal development”. Moreover, the relation of the value groups to four general themes—“Basic beliefs”, “Nature”, “Self”, and “Society”—has been distinguished. This structure, especially on the level of value groups and themes, simply describes the relationships between value items.

The main skeleton of our framework was formed by empirical research. However, the lessons we learnt during the theoretical research helped us select the number of value groups, label them, and relate them to the four general themes. In comparison with the existing value frameworks (Table 1), our final framework (Table 3) is a better fit for design, since our framework address two important criteria: the framework is comprehensive and covers different types of values that are mentioned by various scholars during the last century; and the framework is not applicable to a specific context or group of values. The framework is also well-classified—i.e., it presents a diverse range of human values in different layers. Indeed, in line with the scholars of the early part of the last century, such as Weber, Scheler, Spranger, Perry, and Allport, this framework groups values based on different types of human values. The value groups of the framework are almost comparable with Dooyeweerd’s aspects of reality and seem more able to cover all aspects/dimensions of life. Our nine value groups also have some overlap with Schwartz’s model and in a few cases resemble his value groups: for instance, “Status” resembles Power, “Pleasure” is similar to Hedonism and Stimulation, “Personal development” and “Respect for oneself” can be compared with Achievement and Self-direction. However, the difference appears in “Carefulness”, “Justice”, “Ecology”, and

<sup>5</sup> The labels of value groups were suggested by a group of five persons via several discussions. The labels of value groups are presented in **Bold style**. The value items are presented in *Italic style*. The themes are presented in CAPITAL LETTERS.

**Table 3**  
The value framework including four themes, nine value groups, key values for each value group, and extra values. The rows are sorted alphabetically by theme. Key values are sorted by empirical ranking, and the extra values are sorted alphabetically.

| Theme  | Value Group   | Key value   | Extra value  |
|--|---|---|--|
| BASIC BELIEFS  | Meaningfulness (The quality of searching for meaning in life)   | A spiritual life (emphasis on spiritual not material matters) | Chastity, Holy, Hope, Inner peace, Meaningfulness, Meaning of life, Religiousness, Sacred, Salvation, Spirituality, Tranquility, Transcendence, Truth, Wholeness   |
|  |   | Meaning in life (a purpose in life)                           |  |
|  |   | Inner harmony (at peace with myself)                          |  |
|  |   | Devout (holding to religious faith and belief)                |  |
|  |   | Virtue (piety)  |  |
|  |   | A world at peace (free of war and conflict)                   |  |
|  |   | Unity with nature (fitting into nature)                       |  |
|  |   | Protecting the environment (preserving nature)                |  |
|  |   | A world of beauty (beauty of nature and the arts)             |  |
| NATURE   | Ecology (The quality of caring for nature)                      | Waste avoidance (time, natural sources, opportunities, etc.)  | Appreciation of beauty and excellence, Beauty, Care and concern for the environment, Eco-friendly, Harmony with nature, Magnificence, Sustainability   |
|  |   | Self-respect (belief in one's own worth)                      |  |
|  |   | Responsible (dependable, reliable)                            |  |
|  |   | Self-discipline (self-restraint, resistance of temptation)    |  |
|  |   | Wisdom (a mature understanding of life)                       |  |
|  |   | Intelligent (logical, thinking)                               |  |
|  |   | Independent (self-reliant, self-sufficient)                   |  |
|  |   | Choosing own goals (selecting own purposes)                   |  |
|  |   | Creativity (uniqueness, imagination)                          |  |
| SELF   | Respect for oneself (The quality of regulating yourself)        | Enjoying life (enjoying food, sex, leisure, etc.)             | Self-control, Self-regulation, Self-awareness  |
|  |   | Gratification of desires                                      |  |
|  |   | A varied life (filled with challenge, novelty, and change)    |  |
|  |   | An exciting life (stimulating experiences)                    |  |
|  |   | Honest (genuine, sincere)                                     |  |
|  |   | Kindness (cordiality, tenderness)                             |  |
|  |   | Loyal (faithful to my friends, group)                         |  |
|  |   | Forgiving (willing to pardon others)                          |  |
|  |   | Helpful (working for the welfare of others)                   |  |
| SOCIETY  | Pleasure (The quality of enjoying something or being satisfied) | Freedom (freedom of action and thought)                       | Autonomy, Bravery, Broad-minded, Capable, Competence, Completion, Courage, Daring, Discernment, Education, Flexibility, Knowledge, Intellectualism, Logical, Love of learning, Necessity, Perseverance, Perspective, Physical development, Practicality, Progress, Prudence, Rationality, Self-sufficiency, Utility  |
|  |   | Equality (equal opportunity for all)                          | Cheerful, Effortlessness, Fun, Hedonism, Humor, Imaginative, Material comfort, Playfulness, Simplicity, Stimulation, Teasing, Zest   |
|  |   | Social justice (correcting injustice, care for the weak)      | Altruism, Benevolence, Care and concern for others, Carefulness, Compassion, Courtesy, Empathy, Generosity, Goodness, Gratitude, Humanity, Humility, Integrity, Modesty, Morality, Patience, Philanthropy, Politeness, Selflessness, Temperate   |
|  |   | National security (protection of my nation from enemies)      | Democracy, Fairness, Lawfulness, Legal, Order, Political, Retribution, Security  |
|  |   | Social order (stability of society)                           |  |
|  |   | Healthy (not being sick physically or mentally)               | Accepting my portion in life, Affection, Being together, Clean, Collective life, Conformity, Connectedness, Culture, Customary, Detachment, Individualism, Love, Moderate, Obedient, Privacy, Reciprocity of favors, Respect for tradition, Sense of belonging, Social intelligence, Social skills, Solidarity, Solitude, Teamwork, Tradition, Trust, Universalism |
|  |   | True friendship (close, supportive friends)                   |  |
|  |   | Honoring parents and elders (showing respect)                 |  |
|  |   | Mature love (deep emotional and spiritual intimacy)           |  |
| JUSTICE (the quality of fair and just treatment)         | Respect for others (the quality of connecting to others)        | Successful (achieving goals)                                  | Achievement, Authority, Competition, Fame, Leadership, Perfection, Preserving my public image, Richness, Sense of accomplishment, Social power, Status, Superiority, Uniqueness  |
|  |   | Ambitious (hardworking, aspiring)                             |  |
|  |   | Wealth (material possessions, money)                          |  |
|  |   | Social recognition (respect, approval by others)              |  |
|  |   | Social power (control over others, dominance)                 |  |
|  |   | Freedom (freedom of action and thought)                       |  |
|  |   | Equality (equal opportunity for all)                          |  |
|  |   | Social justice (correcting injustice, care for the weak)      |  |
|  |   | National security (protection of my nation from enemies)      |  |
| RESPECT FOR OTHERS (the quality of connecting to others) | Status (the quality of being distinguished from others)         | Healthy (not being sick physically or mentally)               |  |
|  |   | Family security (safety for loved ones)                       |  |
|  |   | True friendship (close, supportive friends)                   |  |
|  |   | Honoring parents and elders (showing respect)                 |  |
|  |   | Mature love (deep emotional and spiritual intimacy)           |  |
|  |   | Successful (achieving goals)                                  |  |
|  |   | Ambitious (hardworking, aspiring)                             |  |
|  |   | Wealth (material possessions, money)                          |  |
|  |   | Social recognition (respect, approval by others)              |  |

“Respect for others”, in which value items from Universalism, Benevolence, Tradition, Conformity, and Security are shuffled and mixed. The value group of “Meaningfulness” in our framework, which includes spiritual value items such as “A spiritual life”, “Meaning in life”, “Inner harmony”, “Devout”, and “Virtue”, comprises the main difference from Schwartz’s model, since he excluded spirituality at the level of value groups.

Although our insistence on being comprehensive made the list quite long, with almost 200 value items, the layered structure even inside each value group helps us to present the long list in a clear and concise framework. Our value framework does not claim to be universal, but opens up a wide view of human values to the designer and presents all value groups at the same level of importance. Indeed, designers should specify values relevant to each project by analyzing the target group, design situation, goal, and so forth. This means that our framework does not dictate which values are/should be more important or more relevant to design. Even the group labels do not have different directions, and all have positive meanings. In fact, our framework presents the different dimensions of human values without judgment. This feature seems very helpful to avoid ignorance of any value unconsciously by reminding the designer of diverse value groups even if s/he does not value them.

Our value framework provides a comprehensive perspective on human values that can be applied by different design approaches, including VSD, VPD, and VCD, to identify relevant human values. The framework has the potential to be applied in a design process for various purposes. To support designers using this value framework in their design, we also created a design tool, the HuValue tool, based on our comprehensive value framework (see more in Ref. [46]). Generally, the HuValue tool is a means of facilitating thinking about and discussing human values. This tool supports designers with simple but familiar materials during their design process to analyze everything (object/-subject/situation) from a wide value point of view [94]. Also, we propose three applications of HuValue, for analyzing games, defining vision, and core value(s), and also translating the core values to action verbs and mechanics, which shows the capacity for our tool to be used in the game design area, specifically for designing human value-based games [95].

Our research clearly has some limitations. In the theoretical research, we only reviewed literature published in English and focused on “value” as the keyword; therefore relevant contributions in other languages or using other keywords such as strength, quality, capacity, and virtue are not included. In the empirical research, the HVS was available only in the English language and only via the internet. Despite our attempt to make the task of ranking and grouping value items as easy and smooth as possible, many participants mentioned that the task required a lot of effort and needed deep thought, due to the nature of human values. This made the process of finding participants rather challenging. In addition, the survey was designed in a way that gave the most possible freedom to the participant in ranking, grouping, and group ranking the human values, which led to many complexities in the data analysis.

In our future research, we will investigate further possible applications of our framework and test it in professional design projects with senior designers.

#### CRedit authorship contribution statement

**Shadi Kheirandish:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Writing - original draft, Writing - review & editing. **Mathias Funk:** Supervision, Software, Data curation, Writing - review & editing. **Stephan Wensveen:** Supervision. **Maarten Verkerk:** Supervision, Conceptualization. **Matthias Rauterberg:** Supervision, Conceptualization, Methodology, Validation, Formal analysis, Writing - review & editing.

#### References

- [1] P.P. Verbeek, Materializing morality. Design ethics and technological mediation, *Sci. Technol. Hum. Val.* 31 (3) (2006) 361–380.
- [2] I. van de Poel, A.C. van Gorp, The need for ethical reflection in engineering design: the relevance of type of design and design hierarchy, *Sci. Technol. Hum. Val.* 31 (3) (2006) 333–360.
- [3] R.D. Hollander, N.H. Steneck, Science-and engineering-related ethics and values studies: characteristics of an emerging field of research, *Sci. Technol. Hum. Val.* 15 (1) (1990) 84–104.
- [4] I. van de Poel, P.P. Verbeek, Ethics and engineering design, *Sci. Technol. Hum. Val.* 31 (3) (2006) 223–236.
- [5] M.M. Mehalik, M.E. Gorman, A framework for strategic network design assessment, decision making, and moral imagination, *Sci. Technol. Hum. Val.* 31 (3) (2006) 289–308.
- [6] M. Coeckelbergh, Regulation or responsibility? Autonomy, moral imagination, and engineering, *Sci. Technol. Hum. Val.* 31 (3) (2006) 237–260.
- [7] T. Swierstra, J. Jelsma, Responsibility without moralism in technoscientific design practice, *Sci. Technol. Hum. Val.* 31 (3) (2006) 309–332.
- [8] K. Shilton, Values levers: building ethics into design, *Sci. Technol. Hum. Val.* 38 (3) (2012) 374–397.
- [9] M. Steen, Upon opening the black box and finding it full: exploring the ethics in design practices, *Sci. Technol. Hum. Val.* 40 (3) (2015) 389–420.
- [10] K. Shilton, Engaging values despite neutrality: challenges and approaches to values reflection during the design of internet infrastructure, *Sci. Technol. Hum. Val.* 43 (2) (2018) 247–269.
- [11] H. Nissenbaum, D. Walker, Will computers dehumanize education? A grounded approach to values at risk, *Technol. Soc.* 20 (1998) 237–273.
- [12] N. JafariNaimi, Our bodies in the trolley’s path, or why self-driving cars must \*not\* be programmed to kill, *Sci. Technol. Hum. Val.* 43 (2) (2018) 302–323.
- [13] O. Kudina, P.-P. Verbeek, Ethics from within: Google glass, the collingridge dilemma, and the mediated value of privacy, *Sci. Technol. Hum. Val.* (2018) 1–24.
- [14] P. Brey, The strategic role of technology in a good society, *Technol. Soc.* 52 (2018) 39–45.
- [15] C. Voinea, Designing for conviviality, *Technol. Soc.* 52 (2018) 70–78.
- [16] J. Nelson, T. Gorichanaz, Trust as an ethical value in emerging technology governance: the case of drone regulation, *Technol. Soc.* (2019).
- [17] H.A. Simon, *The Sciences of the Artificial*, MIT press, Cambridge, 1996.
- [18] C.A. Le Dantec, E.Y.L. Do, The mechanisms of value transfer in design meetings, *Des. Stud.* 30 (2) (2009) 119–137.
- [19] L. Feijs, k. Overbeeke, Design science: meaning, action and value, in: *Proceedings of the 6th Asian Design International Conference*, Tsukuba, Japan, 2003.
- [20] J. van den Hoven, P.E. Vermaas, I. van de Poel (Eds.), *Handbook of Ethics, Values, and Technological Design*, Springer, Dordrecht, 2015.
- [21] M. Steen, I. van de Poel, Making values explicit during the design process, *IEEE Technol. Soc. Mag.* 31 (4) (2012) 63–72.
- [22] S. Boztepe, The notion of value and design, in: *Proceedings of the Asian Design International Conference*, Tsukuba, Japan, 2003.
- [23] A. Borning, M. Muller, Next steps for value sensitive design, in: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems 2012*, Austin, Texas, 2012.
- [24] OxfordLivingDictionaries, Oxford living dictionaries [Online]. Available: <https://en.oxforddictionaries.com/definition/framework>, 2018. (Accessed 23 April 2018).
- [25] B. Friedman, D.G. Hendry, A. Borning, A survey of value sensitive design methods, *Found. Trends® Hum. Comput. Interaction* 11 (2) (2017) 63–125.
- [26] O.S. Iversen, K. Halskov, T.W. Leong, Value-led participatory design, *Co Design: Int. J. CoCreation Des. Arts* 8 (2-3) (2012) 87–105.
- [27] G. Cockton, A development framework for value-centred design, in: *Proceedings of CHI 2005 Extended Abstracts on Human Factors in Computing Systems*, Portland, Oregon, USA, 2005.
- [28] C. Knobel, G.C. Bowker, Values in design, *Commun. ACM* 54 (7) (2011) 26–28.
- [29] Design for Values, 2018 [Online]. Available: <http://designforvalues.tudelft.nl/>. (Accessed 8 January 2018).
- [30] M.L. Cummings, Integrating ethics in design through the value-sensitive design approach, *Sci. Eng. Ethics* 12 (4) (2006) 701–715.
- [31] I. Oosterlaken, Applying value sensitive design (VSD) to wind turbines and wind parks: an exploration, *Sci. Eng. Ethics* 21 (2) (2015) 359–379.
- [32] S. Kujala, K. Väänänen-Vainio-Mattila, Value of information systems and products: understanding the users’ perspective and values, *J. Inf. Technol. Theor. Appl.* 9 (4) (2008) 23–39.
- [33] N. Manders-Huits, What values in design? The challenge of incorporating moral values into design, *Sci. Eng. Ethics* 17 (2) (2011) 271–287.
- [34] J. Halloran, E. Hornecker, M. Stringer, E. Harris, G. Fitzpatrick, The value of values: resourcing co-design of ubiquitous computing, *CoDesign* 5 (4) (2009) 245–273.
- [35] P. Ross, *Ethics and Aesthetics in Intelligent Product and System Design*, Doctoral dissertation, Eindhoven University of Technology, Eindhoven, The Netherlands, 2008.
- [36] L.V. Onselen, R. Valkenburg, Personal values as a catalyst for meaningful innovations: supporting young designers in collaborative practice, in: *Proceedings of the 20th International Conference on Engineering Design (ICED 15)*, Milan, Italy, 2015.
- [37] C.A. Detweiler, *Accounting for Values in Design*, Doctoral dissertation Delft University of Technology, Delft, The Netherlands, 2016.

- [38] O.S. Iversen, K. Halskov, T.W. Leong, Rekindling values in participatory design, in: Proceedings of the 11th Biennial Participatory Design Conference, Sydney, Australia, 2010.
- [39] P. Saariluoma, J.J. Cañas, J. Leikas, *Designing for Life*, Palgrave Macmillan, London, 2016.
- [40] M. Malpass, Between Wit and reason: defining associative, speculative, and critical design in practice, *Des. Cult.* 5 (3) (2013) 333–356.
- [41] M.B. Miles, A.M. Huberman, *Qualitative Data Analysis: an Expanded Sourcebook*, SAGE, 1994.
- [42] S. Schwartz, Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries, *Adv. Exp. Soc. Psychol.* 25 (1992) 1–65.
- [43] B. Friedman, J.P.H. Kahn, A. Borning, A. Hultgren, Value sensitive design and information systems, in: N. Doorn, D. Schuurbers, I. van de Poel, M. Gorman (Eds.), *Early Engagement and New Technologies: Opening up the Laboratory* vol. 16, Springer, Dordrecht, 2013, pp. 55–95.
- [44] C.L. Jurkiewicz, R.A. Giacalone, A values framework for measuring the impact of workplace spirituality on organizational performance, *J. Bus. Ethics* 49 (2) (2004) 129–142.
- [45] M.V. Goubko, A.I. Danilenko, Mathematical model of hierarchical menu structure optimization, *Autom. Rem. Contr.* 73 (8) (2012) 1410–1423.
- [46] S. Kheirandish, *HuValue- A Tool to Enrich Design Concepts with Human Values*, Doctoral Dissertation, Eindhoven University of Technology, Eindhoven, The Netherlands, 2018.
- [47] M. Weber, *The Protestant Ethic and the Spirit of Capitalism*, Charles Scribner's Sons, New York, 1930.
- [48] G. Smith, Review of "what is value? By Risieri Frondizi, *Libertarian Rev.* 1 (1976) 5.
- [49] W. Hague, *Value Systems and Vocational Choice of the Priesthood*, Doctoral dissertation, The University of Alberta., 1968.
- [50] C.L. Sheng, Q. Sheng, *Utilitarian General Theory of Value*, vol. 61, Brill Rodopi, Amsterdam, 1998 p. (Vol. 61). Rodop.
- [51] R.A. Hunt, The interpretation of the religious scale of the Allport-Vernon-Lindzey study of values, *J. Sci. Stud. Relig.* 7 (1) (1968) 65–77.
- [52] C. Morris, *Varieties of Human Value*, University of Chicago Press, 1956.
- [53] T. Gallagher, The value orientations method: a tool to help understand cultural differences, *J. Ext.* 39 (6) (2001), 165–17.
- [54] M. Rajamanickam, *Contemporary Fields of Psychology and Experiments*, Concept Publishing Company, 1999.
- [55] W.A. Scott, *Values and Organizations: A Study of Fraternities and Sororities*, Rand McNally, Chicago, 1965.
- [56] R.M. Williams, *American Society: A Sociological Interpretation*, Knopf, New York, 1970.
- [57] M. Rokeach, *The Nature of Human Values*, The Free Press, New York, 1973.
- [58] C. Peterson, M.E. Seligman, *Character Strengths and Virtues: A Handbook and Classification*, vol. 1, Oxford University Press, 2004.
- [59] E.O. Svee, J. Zdravkovic, C. Giannoulis, Consumer value-aware enterprise architecture, *Soft. Bus.* 114 (2012) 55–69.
- [60] R. Mahamuni, K. Kalyani, P. Yadav, A simplified approach for making human values central to interaction design, *Procedia Manuf.* 3 (2015) 874–881.
- [61] J.A. Lane, The care of the human spirit, *J. Prof. Nurs.* 3 (6) (1987) 332–337.
- [62] A.H. Maslow, *Religions, Values, and Peak-Experiences*, vol. 35, Ohio State University Press, Columbus, 1964.
- [63] A.H. Maslow, Self-actualization and beyond, in: Proceedings of the Conference on the Training of Counselors of Adults, Winchester, MA, 1965.
- [64] S. Walker, The manifestation of meaning. A discussion of the environmental, social and spiritual aspects of product design, *Des. J.* 2 (2) (1999) 2–9.
- [65] S. Walker, Design and spirituality: material culture for a wisdom economy, *Des. Issues* 29 (3) (2013) 89–107.
- [66] B.J. Zinnbauer, K.I. Pargament, B. Cole, M.S. Rye, E.M. Butter, T.G. Belavich, K. M. Hipp, A.B. Scott, J.L. Kadar, Religion and spirituality: unfuzzifying the fuzzy, *J. Sci. Stud. Relig.* 36 (1997) 549–564.
- [67] G.F. Cavanagh, Spirituality for managers: context and critique, *J. Organ. Change Manag.* 12 (3) (1999) 186–199.
- [68] M.J. Brady, A.H. Peterman, G. Fitchett, M. Mo, D. Cella, A case for including spirituality in quality of life measurement in oncology, *Psycho Oncol.* 8 (5) (1999) 417–428.
- [69] D.P. Ashmos, D. Duchon, Spirituality at work: a conceptualization and measure, *J. Manag. Inq.* 9 (2) (2000) 134–145.
- [70] J.C. Stuckey, Blessed assurance: the role of religion and spirituality in Alzheimer's disease caregiving and other significant life events, *J. Aging Stud.* 15 (1) (2001) 69–84.
- [71] U. King, *The Search for Spirituality: Our Global Quest for a Spiritual Life*, BlueBridge, 2008.
- [72] A. Woodruff, S. Augustin, B. Foucault, Sabbath day home automation: it's like mixing technology and religion, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2007.
- [73] S.P. Wyche, K.E. Caine, B.K. Davison, S.N. Patel, M. Arteaga, R.E. Grinter, Sacred imagery in techno-spiritual design, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2009.
- [74] C.R. Gorman, Religion on demand: faith-based design, *Des. Cult.* 1 (1) (2009) 9–22.
- [75] L. Di Lucchio, Design for faith. A performative change, from design of function to design of meaning, in: 8th European Academy of Design Conference, Aberdeen, Scotland, 2009.
- [76] W. Gaver, M. Blythe, A. Boucher, N. Jarvis, J. Bowers, P. Wright, The prayer companion: openness and specificity, materiality and spirituality, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2010.
- [77] J. Vidyarthi, B.E. Riecke, D. Gromala, Sonic Cradle: designing for an immersive experience of meditation by connecting respiration to music, in: Proceedings of the Designing Interactive Systems Conference, 2012.
- [78] N.A. Ahmad, F. Hanis, A. Razak, On the emergence of techno-spiritual: the concept and current issues, in: Computer and Mathematical Sciences Graduates National Colloquium 2013 (SISKOM2013), 2013.
- [79] M. Blythe, E. Buie, Chatbots of the gods: imaginary abstracts for techno-spirituality research, in: Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational, 2014.
- [80] H. Bağlı, Material culture of religion: new approaches to functionality in Islamic objects, *Des. J.* 18 (3) (2015) 305–325.
- [81] E. Buie, *Exploring Techno-Spirituality: Design Strategies for Transcendent User Experiences*, Doctoral dissertation, Northumbria University, 2018.
- [82] *Oxford learners dictionaries [Online]*. Available: <https://www.oxfordlearnersdictionaries.com/definition/english/spirituality?q=spirituality>, 2019. (Accessed 2 December 2019).
- [83] J.D. Emblen, Religion and spirituality defined according to current use in nursing literature, *J. Prof. Nurs.* 8 (1) (1992) 41–47.
- [84] L.K. George, D.B. Larson, H.G. Koenig, M.E. McCullough, Spirituality and health: what we know, what we need to know, *J. Soc. Clin. Psychol.* 19 (1) (2000) 102–116.
- [85] C. Delgado, A discussion of the concept of spirituality, *Nurs. Sci. Q.* 18 (2) (2005) 157–162.
- [86] S.H. Nasr, *Religion and the Order of Nature*, Oxford University Press, New York, 1996.
- [87] K.I. Pargament, The psychology of religion and spirituality? Yes and no, *Int. J. Psychol. Relig.* 9 (1) (1999) 3–16.
- [88] H. Dooyeweerd, A new critique of theoretical thought, in: *The General Theory of the Modal Spheres*, vol. 2, H.J. Paris, 1955.
- [89] A. Basden, A presentation of Herman Dooyeweerd's aspects of temporal reality, *Int. J. Multi-Aspectual Pract.* 1 (1) (2011) 1–40.
- [90] H. Berkhof, Wm. B. Christian Faith, Eerdmans Publishing, 2010.
- [91] A.S. Cheng, K.R. Fleischmann, Developing a meta-inventory of human values, in: Proceedings of the Association for Information Science and Technology, 2010.
- [92] B. Martin, B. Hanington, *Universal Methods of Design*, Rockport Publishers, Beverly, Massachusetts, 2012.
- [93] C. Hennig, M. Meila, F. Murtagh, R. Rocci (Eds.), *Handbook of Cluster Analysis*, CRC Press, 2015.
- [94] S. Kheirandish, M. Funk, S. Wensveen, M. Verkerk, M. Rauterberg, HuValue: a tool to support design students in considering human values in their design, *Int. J. Technol. Des. Educ.* (2019) 1–27.
- [95] S. Kheirandish, M. Rauterberg, Human value based game design, in: Proceedings of 2nd National and 1st International Digital Games Research Conference: Trends, Technologies, and Applications (DGRC), Tehran, Iran, 2018.
- [96] A. Crossman, *Index of Qualitative Variation (IQV)*, 1 May 2017 [Online]. Available: <https://www.thoughtco.com/index-of-qualitative-variation-iq-v-3026700>. (Accessed 19 May 2018).
- [97] C. Taylor, *Understanding the interquartile range in statistics [Online]*. Available: <https://www.thoughtco.com/what-is-the-interquartile-range-3126245>, 7 June 2017. (Accessed 19 May 2018).
- [98] L.R. Kahle, P. Kennedy, Using the list of values (LOV) to understand consumers, *J. Serv. Market.* 2 (4) (1988) 49–56.