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Abstract. Public values are desires of the general public, that are about properties considered societally valuable, such as respecting the privacy of citizens or prohibiting polluting activities. "Translating" public values into functional solutions is thus an actual challenge. Even though Value-Sensitive Design (VSD) is about weaving public values in the design of (technical) systems, it stays insufficiently concrete as it concerns the alignment between abstract public values and technical (software) solutions. Still, VSD indirectly inspires ideas in that direction as for example the idea to consider business process variants for achieving such an alignment. Nevertheless, this is all about "atomic" public values (encapsulating only one particular behavioral goal) while one would often face public values that are "composite" in the sense that they reflect a particular human attitude rather than just a desired behavioral goal. In the current paper, we propose a value decomposition approach that allows for operationalizing composite public values. We also present experimental results featuring data analytics using self-administrated surveys.

Keywords: Public values · Software specification · Data analytics

1 Introduction

Public values ("values", for short) are *desires of the general public*, that are about *properties considered societally valuable*, such as respecting the privacy of citizens or prohibiting polluting activities [10]. "Translating" *values* into *functional solutions* is thus an actual challenge. Even though *Value-Sensitive Design* (*VSD*) is about *weaving values in the design* of (technical) systems [3], we argue that it stays insufficiently concrete as it concerns the *alignment between abstract* values and *technical (software)*

solutions. Still, VSD indirectly inspires ideas in that direction as for example the idea of Shishkov & Mendling to consider *business process variants* as a "bridge" in achieving such an alignment [10].

Nevertheless, this is all about **atomic values** (<u>encapsulating only one particular behavioral goal</u>) while one would often face values that are **composite** in the sense that they <u>reflect a particular human attitude</u> rather than just a desired behavioral goal. An example for the former is the desire to realize something in a *privacy-sensitive* way [8]; an example for the latter is the desire to achieve *egalitarianism* [2].

Whereas, *atomic values* are <u>weave-able in the (software) design</u>, as studied by Shishkov et al. [8–10], they are claimed to be not very "instrumental" as it concerns social feedback. In our view that is because most of those values (such as *privacy*, *transparency*, *accountability*, and so on) are to be considered <u>in a particular context</u> [8, 9, 11]. Then people consider them differently depending on the context. For example: USUALLY, privacy is desired but when HUNTING TERRORISTS, it might be acceptable by many people that authorities compromise their privacy. Therefore, studying in general what somebody's attitude is towards privacy (for example), could be of limited use. For this reason, we argue that *atomic values could only be adequately operationalized if this concerns context-aware systems* [9].

Composite values, in contrast, are not so easy to weave in the design (because they are even more abstract than atomic values) but <u>it is easier to capture public opinion concerning them</u> through surveys (or other analyses), as it is claimed by Veenhoven & Kalmijn [13] – they argue that many issues that concern composite public values (such as *egalitarianism*, *utilitarianism*, *autonomy*, *embeddedness*, and so on) *can be measured using surveys*.

Therefore:

- *Atomic values* can be operationalized but it is not easy justifying this as a public demand;
- It is not straightforward operationalizing *composite values* but the need for this can be "measured".

We propose a **value decomposition approach** that allows for operationalizing *composite values*. We also present **experimental results** featuring *data analytics using self-administrated surveys*.

Even though the **value concept** (assuming *atomic values*) is crucial with regard to this work, we are not presenting and discussing ATOMIC *values* in the current paper because this is done in other papers from the current proceedings – hence, we refer readers to [9, 10].

The remaining of the paper is organized as follows: In Sect. 2, we briefly introduce and discuss composite values, emphasizing on their societal relevance. In Sect. 3, we present our value decomposition approach that is supposed to be helpful to designers in their operationalizing also composite values if necessary. In Sect. 4 we present relevant experimental results. Finally, in Sect. 5, we conclude the paper.

2   Composite Values

In considering *composite values* from a social sciences perspective, we refer to Shalom Schwartz according to whom every culture can be described by 7 universal value orientations (categories), namely: *embeddedness*, *intellectual autonomy*, *affective autonomy*, *hierarchy*, *egalitarianism*, *harmony*, and *mastery* [6]:

- Embeddedness ("EMB", for short) focuses on maintaining the status quo and limiting the actions and inclinations that can disrupt the solidarity of the group or the imposed traditional order;
- Intellectual autonomy ("AUT", for short) expresses the aspirations of individuals to pursue their own ideas and independent intellectual purposes;
- Affective autonomy (AUT) expresses the desire of individuals to acquire affective positive experience;
- Hierarchy ("HIE", for short) emphasizes the legitimacy of the unequal distribution of power, roles, and resources;
- Egalitarianism ("EGA", for short) reveals the transcendence of individual interests in favor of voluntary commitment and concern for the welfare of others;
- Harmony ("HAR", for short) discloses the unity with the environment;
- Mastery ("MAS", for short) gives priority to active self-assertion and control of the social and natural environment.

EMB, EGA, and HAR are hence *collectively-oriented* values while AUT, HIE, and MAS are *individually-oriented* ones. Further, "tensions" are possible between two composite values if they cannot be fulfilled simultaneously, for example:

- EMB vs. AUT (the undifferentiated versus the differentiated from the group individual);
- HIE vs. EGA (inequality versus equality);
- MAS vs. HAR (control and change versus adaptation to the environment).

3   Concepts and Approach

Referring to the discussion carried out in the previous two sections, and considering two main concepts, namely "atomic value" and "composite value", we arrive at a conceptual view, as illustrated in Fig. 1, using the notations of UML - Class Diagram [12]: those two concepts are represented as two main value types. As the figure indicates, a *composite value* is composed of one or more *atomic values*. Further, the figure suggests, it is not straightforward decomposing a *composite value* in terms of corresponding *atomic values* (see the question mark in the figure) and a limitation of the current paper is that we have not explicitly tackled this issue leaving it for further research.
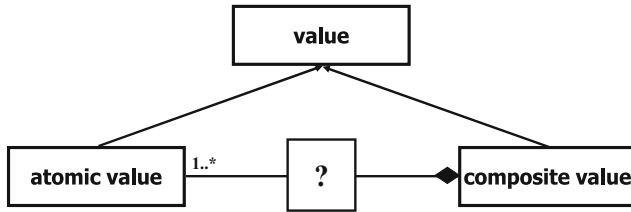
Fig. 1. Atomic values and composite values – conceptual view

Still, it is our **assumption** that *such a decomposition is possible*, acknowledging nevertheless that such complex social categories are not straightforwardly implementable – how, if we take the example of *egalitarianism*, an information system would establish that all people are equal and have equal rights and opportunities? We argue that an information system could "enforce" a number or relevant atomic values, such as *transparency*, *justice*, and *accountability* whose implementation **in combination** would in turn contribute to achieving *egalitarianism*. Hence, in this particular case, one would intuitively decompose *egalitarianism* into *transparency + justice + accountability* but maybe this would be more difficult for other *composite values*.

Thus, we assume that this is possible even though we have not yet delivered exhaustive *justification* that any *composite value* can be decomposed in terms of corresponding *atomic values*.

Anyway, the above assumption and the conceptual positioning (see Fig. 1) are already useful, inspiring the derivation of a **general approach** envisioning composite values and the way to consider them in support of system design – see Fig. 2; we have used the notations of the UML - Activity Diagram [12], keeping the approach also consistent with the **SDBC approach** [7].
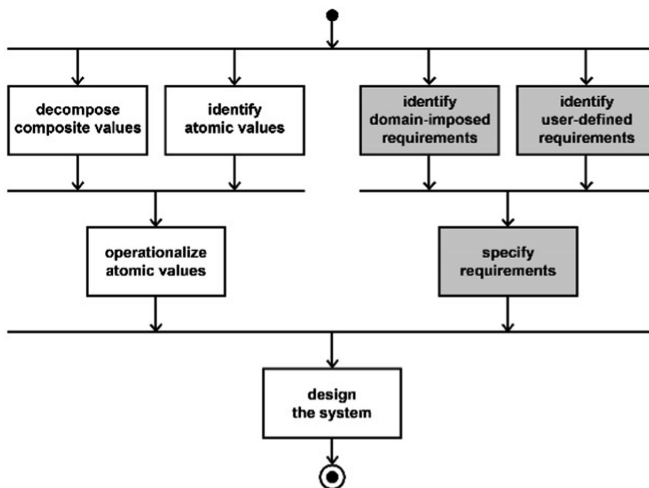

Fig. 2. Approach elaboration

As the figure suggests, it is not only the **requirements specification** [1] but also the **operationalization of atomic values** [9], that are needed as input for the (software) system design – we refer to the conclusion of Shishkov & Mendling that it is "important to clearly distinguish values from requirements and acknowledge the limitations of requirements engineering with regard to the development of value-sensitive software systems" [10]. For this reason we do not consider the operationalization of values as part of the requirements specification, as seen from the figure. Both *domain-imposed requirements* and *user-defined requirements* are functional while *values* are *non-functional* in essence - for this reason, they need to be operationalized and this means "translating" them into *functional solutions*, and this goes beyond *requirements engineering*. It is not even the non-functional requirements that change this because values cannot be limited to non-functional requirements, as studied in [10].

Further, it could be that:

- We have already a demand to enforce particular atomic values (for example: the system should be *privacy-sensitive*) or;
- We have a public demand to reinforce a particular composite value (for example: the system should be instrumental with regard to pushing forward egalitarianism in society); then, it would be necessary to somehow decompose this composite value (taking the previously discussed example, *egalitarianism* is decomposed into *transparency + justice + accountability*).

Finally, as above-mentioned, the proposed design approach is consistent with SDBC [7] and all further design/modeling activities could proceed according to SDBC (and for this reason, we abstract from those activities in the current paper); moreover, SDBC has been applied in addressing the specification of value-sensitive systems [8, 9]. We hence only emphasize on the importance of decomposing composite values, such that they are adequately reflected in the corresponding software specifications.

In the following section we present experimental results that justify the claim that it is easier to capture public opinion concerning composite values (see Sect. 1). We consider composite values in general and **cultural values** – in particular, referring to the categorization of Schwartz (see Sect. 2).

4   Experimental Results

In *October – December 2017*, an **online questionnaire survey** via Google forms, applying Schwartz's methodology for measuring cultural values [6] among *Bulgarian entrepreneurs* was carried out. It contains 44 items (values) such as social power, success, freedom, etc. By using a 9-point scale (from 0 – not important to 7 – extremely important and [−1] – contrary to my values) every respondent assesses the importance of each value as a guiding principle in his/her life. Those values are grouped into six value categories (orientations) and three bipolar dimensions (alternatives).

4.1   Briefing

The number of Bulgarian entrepreneurs studied was 234. All of them fall within the age range 19-68 y.o. (average age M = 35.35; SD = 10.91): 68 are men (29.1%), 166 – women (70.9%); education – secondary 97 (41.5%), college 8 (3.4%), and university 129 (55.1%); marital status – single 68 (29.1%), married – 97 (41.5%), separated/divorced – 20 (8.5%), in cohabitation with partner 47 (20.1%), and widower/widow 2 (0.9%); residence – Sofia (capital) 167 (71.4%), regional city 48 (20.5%), another town 11 (4.7%), and village 8 (3.4%). All respondents develop private business in the field of information technology, commerce, food processing, education, pharmacy and healthcare, and others. They are owners of small and medium-sized enterprises.

4.2   Results

The empirical data is processed using *IBM SPSS Statistics 19* [5]. To test the hypotheses of the study a series of Paired-Samples T-Tests is considered. The results about value alternatives are summarized in Tables 1 and 2.

Table 1. Paired samples statistics

		Mean	N	Std. deviation	Std. error mean
Pair 1	EMB	5.33	234	0.87	0.06
	AUT	5.21	234	1.02	0.07
Pair 2	HIE	3.86	234	1.29	0.08
	EGA	5.49	234	0.90	0.06
Pair 3	MAS	5.48	234	0.98	0.06
	HAR	5.18	234	1.33	0.09

Table 2. Paired samples test

	Paired differences					t	df	Sig.(2-tailed)
	Mean	Std. dev.	Std. error mean	95% Confidence interval of the difference				
				Lower	Upper			
Pr 1	0.12	0.91	0.06	0.004	0.237	2.04	233	0.043
Pr 2	−1.62	1.33	0.09	−1.796	−1.454	−18.74	233	0.000
Pr 3	0.31	1.30	0.08	0.140	0.474	3.62	233	0.000

The mathematical and statistical analysis reveals that embeddedness dominates autonomy (x = 5.33 vs. x = 5.21 at t = 2.04 and p = 0.043), egalitarianism over hierarchy (x = 5.49 vs. x = 3.86 at t = −18.74 and p = 0.000), and mastery over harmony (x = 5.48 vs. x = 5.18 at t = 3.62 and p = 0.000), as mean values of the
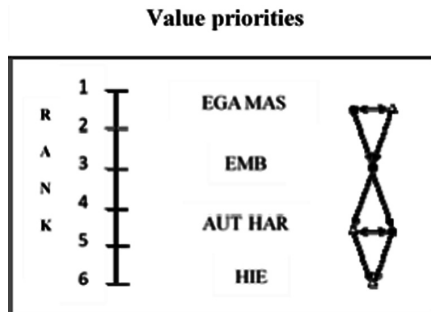
variables are statistically significant at p < 0.05. In other words, in the case of entre-preneurs, value conflicts are dealt with in favor of values of status quo, equal social relations and exploitation of environment. The results obtained partly confirm the hypothesis that individual values have predominance over collective values.

The analysis of the structural and hierarchical organization of values allows for a profound look into the value priorities of Bulgarian entrepreneurs. For that purpose, the mean of value categories is sorted in descending order. Rank 1 receives the value with the highest mean and rank 7 – the lowest one. By Paired-Samples T-Test statistically (in)significant differences between each pair of variables are tested. The type of values with statistically significant differences in the mean is classified with a single rank and those with insignificant difference share the same rank with other values (see Table 3). The structural-hierarchical model, where collective values are marked with a black circle and the individual ones – with a white triangle, is shown in Fig. 3.

Table 3. T-values from the comparison of each pair of value categories ($^\alpha$p < 0.05; $^\beta$p < 0.01; $^\gamma$p < 0.001)

	EGA	MAS	EMB	AUT	HAR	HIE	M	SD	R
EGA	–	0.07	4.03^γ	4.37^γ	4.11^γ	18.74^γ	5.49	0.90	1.5
MAS		–	2.85^β	5.05^γ	3.62^γ	23.12^γ	5.48	0.98	1.5
EMB			–	2.04^α	2.09^α	17.94^γ	5.33	0.87	3
AUT				–	0.40	18.00^γ	5.21	1.02	4.5
HAR					–	12.74^γ	5.18	1.33	4.5
HIE						–	3.86	1.29	6

Fig. 3. Structural-hierarchical model of entrepreneurs surveyed in 2017

The visualization of the data in Fig. 3 shows that the value hierarchy of Bulgarian entrepreneurs consists of 4 structural levels: <u>Level I</u> with a shared rank of 1, 5 places egalitarianism and mastery, <u>Level II</u> with rank 3 – embeddedness, <u>Level III</u> with rank 4, 5 – autonomy and harmony, and <u>Level IV</u> with rank 6 is hierarchy. Value priorities are outlined by egalitarianism, mastery, and embeddedness. Hence the empirical facts

describe the entrepreneurs' value order as internally contradictory and in a process of transformation. Evidence of this is the high position of egalitarianism and embeddedness, which are defined as values from the old ideological system of socialism [4], as well as the lower importance of autonomy and hierarchy which are values of modern society.

On the basis of the presented results, it can be speculated that the entrepreneurial culture in Bulgaria is still in the process of development and formation. The lack of a strong business elite and economic leadership, measured through the prism of cultural values and related behavioral models, is to be noted. The high importance of embeddedness in comparison with autonomy (intellectual and affective), for example, is probably due to the fact that in Bulgaria many businesses are family-run. This largely reproduces the characteristics of the national culture that occupies the forefront of embeddedness, conservatism, and collectivism.

5   Conclusion

Public values are an intuitive appealing concept that is not always easy to capture. This especially holds for atomic public values whose capturing would often assume complex trade-offs and situation-dependency. At the same time, atomic values can be methodologically reflected in technical (software) functional solutions (hence – operationalized). In contrast, composite values are difficult to operationalize but are easier to capture and measure, possibly through surveys. In this paper we have proposed value decomposition with regard to composite values, in terms of corresponding atomic values. Acknowledging the possibility to methodologically operationalize atomic values, we have justified by means of an experiment the possibility to capture and analyze composite values. Thus, capturing composite values + decomposing them in terms of atomic values + operationalizing the atomic values is expected to be an adequate approach for dealing with (composite) values, especially if they need to be reflected in specifications of information systems. This is research in progress and both the propositional and the validation parts of the current paper require further elaboration. We plan this as future research.

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