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# Epos – an instrument for the assessment of the ethical position in software development

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**ABSTRACT**

Digital technology becomes more powerful, intelligent, pervasive and ubiquitous. Ethical aspects of this development have not yet drawn the appropriate attention of researchers and engineers. This paper presents an instrument that aims at measuring the individual ethical position with regard to the design and development of computer software. The development of the Epos tool was based on two data collections. The data of the first survey ($n_1 = 147$ participants) were used to select items and to determine the factorial structure of the questionnaire. Results show that the Epos instrument reliably assesses peoples' ethical opinion with respect to five central components: (1) regulation, (2) data privacy, (3) domain specific knowledge, (4) societal responsibility and (5) company responsibility. In the second survey, we determined the stability of the instruments factor structure by assessing a sample of $n_2 = 196$ participants. A confirmatory factor analysis (CFA) supported the initial factor structure. Next steps and further implications are discussed regarding the final version of the questionnaire.

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Applied ethics; technology research and development practice; man–machine interaction (MMI); attitude assessment; questionnaire development

## Relevance to human factors/Relevance to ergonomics theory

Modern computer technology development is an interdisciplinary and rapidly evolving activity (Brynjolfsson & McAfee, 2011). Emerging trends in today's technology development, like automation, data mining, networking of systems, smart objects, and the Internet of Things bring new challenges to ethics and render ethical conduct increasingly important (Manzeschke, 2015). Brandenburg (2015, 2017) showed that technology researchers and developers have problems taking care about data security issues. He also concluded that engineers might not have sufficient knowledge about ethical aspects of their work. Few methods have been developed and implemented to ethically guide engineers and researchers to reflect on ethical issues during the product development process. This paper presents Epos – an instrument for the assessment of the ethical position regarding software development. The instrument is relevant for many human factors researchers and developers because it sensitizes them to consider the ethical aspects of their work.

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## 1. Introduction

Being an engineer demands a high ethical standard. After the Second World War, leading physicists, like Albert Einstein and Max Born, discussed the meaningfulness of an oath for engineers (Ropohl 1996). The idea was that engineers should swear to use their knowledge only for the best of manhood, their work should respect humans' dignity, and they should oppose to those that disregard peoples' rights (reprinted in Lenk and Ropohl 1993). Since the time of Albert Einstein and Max Born, many guidelines, standards, and codes of conduct evolved to guide engineers during the process of technology research and development. In 1996, more than 151 of them existed for engineers only (Ropohl 1996) and more have been formulated since, for example the software code of ethics (Gotterbarn, Miller, and Rogerson 1997).

Ethics are often referring to codes of conduct of specific groups or individuals within a society who, for example, have the same profession or work in the same institution. Medical ethics, political ethics and engineering ethics are good examples of profession-related ethics. A member of a profession is ethically obliged to act in accordance with the specific standards of his or her profession. If standards are not met, the quality of the product or service that is delivered can be unsatisfying and a loss in trust for the entire group or institution may occur.

Modern computer technology development is an interdisciplinary and rapidly evolving activity (Brynjolfsson and McAfee 2011). Emerging trends in today's technology development like automation, data mining, networking of systems, smart objects, and the Internet of Things (IoT) bring new challenges to ethics and render ethical conduct increasingly important (Manzeschke 2015). Data privacy, personal autonomy, self-determination and the question of how we want to live in the future are only some of the most important ethical aspects in today's highly technologised world. These questions need to be addressed by politicians, lawyers, engineers, institutions, and by other members of a society, such as end users and customers of a service.

The increasing pervasion of digital technologies in our everyday lives often leads to ethical issues. Most of these challenges and questions concerning ethical aspects arise in early phases of the development process, e.g. in the ideation and concept phase. However, they may completely change and considerably expand in the course of specifying and implementing a product solution. Brandenburg (2015) and Manzeschke (2015) conclude that there is a strong need to consider ethical aspects at the early stage of product development, the stage of research, and throughout the whole product development process. For instance, Manzeschke et al. (2013) proposed workshops for technology development in the ambient assisted living domain (AAL), which include a professional ethicist for ethical guidance during the complete technology development process. Resnik (2005) describes morality as a set of very basic standards of a society broadly distinguishing between good and bad, right and wrong, fair and unfair. However, particularly in early stages, this distinction is often unclear as the future use (or misuse) of a product is difficult to anticipate.

For instance, research by Mundt, Krüger, and Wollenberg (2012) nicely illustrates how everyday technology can be used to easily draw inferences about peoples' behaviour in private situations. The authors used the data that were provided by modern house installation networks, i.e. movement-sensitive lightning in an office floor, to

track peoples' movements. By collecting and merging different data, like individual walking speed patterns and the knowledge about who works in which office, it was possible to reliably identify individuals and even determine who did not wash hands properly after using the restroom. This example illustrates how complicated it is to detect ethical issues in early stages of product development. It also emphasises the importance of an engineer's awareness of potential problems and the willingness to engage early in finding risk-minimising solutions. Could the engineers who developed the house installation networks and the movement-sensitive lightning foresee this kind of analysis and consequently that their product might harm peoples' privacy? If yes, should they have returned to implement only manual light switches? Or should they have redesigned their product in a way that guarantees privacy?

Quite a large debate exists as to whether innovation and creativity has a dark side (Cropley 2010) or not (Runco 2010). The dark side of innovation, or 'negative creativity' (James 2010), could be associated with unintended consequences of technology use. The multidisciplinary approach of product development and the involvement of users in early stages of design and evaluation activities might be a promising way to anticipate potential sources for intentional misuses as well as for unintentional incorrect use of technology.

To uphold the aspiration, most technology is nowadays thought to be highly user-centred and usable. For example, usage data are collected, user needs are assessed, and prototypes are built based on ideas or suggestions from customers or participants. Burmeister (2001) pointed out that the treatment of participants, the protection of intellectual property, the freedom to participate in usability tests and the privacy of study participants are main ethical points in usability engineering. Brandenburg, Minge, and Cymek (2017) empirically derived six rules of thumb to detect and overcome frequent ethical issues when involving humans in technology research and development. These rules are: (1) provide an easy and understandable description of your study's procedure, (2) provide full anonymisation of user data, (3) keep in mind that data belong to participants, (4) never force your participants, (5) handle humans with care, provide breaks and (6) appreciate the collaboration of participants, provide rewards. The authors conclude that these simple rules of thumb might help to consider ethical aspects in the human centred technology development process.

The IoT is a further domain highlighting the prominent role of ethics in technology development. IoT is an ongoing revolution in the digital age and 'it is far bigger than anyone realizes' (Burros 2014, wired.com). Whether IoT turns out to be revolutionary or not – it includes options that widely affect everyday life. Technicians and researchers have numerous alternatives exploiting the technical aspects of IoT, and they are striving after them. But who thinks about the non-technical aspects of IoT? Some of them relate to issues before IoT services are developed and others to issues after IoT services are deployed. Before an IoT service is put in place, it could be asked whether it is indispensable. This type of question is not only connected to business considerations but also, for example, to other consequences ensuing from the IoT service as to data security, or privacy issues. After an IoT service is deployed, challenging ethical questions evolve as well. User data for example could be regarded as an individuals' property and not a company's one (cf. Brandenburg et al. 2017; Bohannon 2015), which is in line with law

principles, such as the European Union's General Data Protection Regulation (GDPR). Accordingly, one could argue that companies or researchers who gather user data are increasing their possession, not their property. Hence, they would be allowed to use their possession as determined by the individual that owns the property, which is the user. However, even if one argues that data that are being assessed by IoT services can be regarded as the companies' or researchers' property, the ethical issues would not vanish, they would change. Property would oblige the owner to deal responsibly with it. One implication of responsibility could mean doing good for the public.

Common practice does not always perfectly comply with the spirit of ethical standards and law regulations. Most end user license agreements (EULA), for example, give a company almost every right to use and to analyse individual usage data. These discrepancies between the 'ideal picture' and the actual behaviour with regard to acting in accordance with ethical guidelines can often be observed, for engineers and developers, but also for users. Phenomena, such as the privacy paradox (Debatin 2011), nicely illustrate that users not always behave in accordance with their own values and ethical principles, whether intentionally or through negligence. Personal awareness of one's own ethical position could therefore be seen as a necessary, but not sufficient precondition for ethical behaviour.

The present paper takes the first step in a step-by-step development of the Epos (*e*thical *po*sition in *s*oftware development) instrument measuring potential discrepancies between personal values and actual behaviour. This tool might be very helpful to identify individual ethics potentials and resources. It might also help screening for the need to apply ethical countermeasures to engineers, developers, and researchers. As a first step, the present paper describes the development of a short and practical instrument measuring the 'ideal world', i.e. the awareness of a person's ethical values.

## 2. Method

To find and formulate an appropriate item pool for the questionnaire, we conducted a literature review and multiple brainstorming sessions. In the literature review, we extracted and analysed the most important aspects of ethical conduct in software development. In the brainstorming sessions, human factors experts and researchers from the field of human–computer interaction complemented the results of the literature review with aspects and items originating from their working experience. One researcher was also chair of a local ethics committee having already reviewed a number of research projects. We tried to include as many ethical aspects regarding computer software as possible. The process of item generation was driven inductively. Throughout the sessions, items were iteratively formulated and reformulated as statements and sorted into six categories: economy (26 items), company processes (13 items), company budget/resources (2 items), product development (3 items), data privacy (6 items) and society (4 items). The formulation of all items was qualitatively pretested with regard to clarity and comprehensibility. The initial item pool of the questionnaire consisted of 54 items, all aligning to the same basic understanding of ethics originally formulated by Tugendhat (1993). He defined ethics as a group discussion of the individual morality of the group members. Different individual viewpoints converge to a joint ethical position.

Tugendhat's (1993) general principle reflects the philosophical background of the items that were formulated during the process of item generation: treat everybody the same, do not exploit anybody. A higher agreement to each item therefore results in a higher Epos score reflecting a higher agreement with Tugendhat's principle. Epos therefore assesses peoples' opinion about ethical aspects of software development, which we call ethical position. The items were formulated and tested in German.

### 2.1. Participants

A total of $N = 143$ participants (58 females, 40%) answered the initial item pool of the questionnaire. Their age ranged from 17 to 60 years ($M = 26.41$yrs, $SD = 5.5$ years). Eighty-seven (61%) obtained a university degree, 19 (13%) completed a vocational college, 18 (12%) held a degree from an applied university and 17 (12%) achieved other education. Of all participants, 113 (79%) were students (mostly engineering sciences), 26 (18%) were employed and 3 (2%) had other obligations. Most of the participants (88, 62%) had no experience in software development; however, 54 (37%) were experienced. A large amount of the participants ($n = 104$, 73%) expressed constant interest in new technologies and software products, 32 (22%) stated to be sometimes interested and only 6 (4%) were not interested at all. Finally, 72 (50%) of the participants used their digital devices (computer and smartphone) between 3 and 8 h a day. Another 50 respondents (35%) used their devices for more than 8 h per day and only 20 (14%) for less than 3 h a day.

### 2.2. Questionnaire and procedure

The questionnaire consisted of three parts. First, participants were instructed about the purpose of the study, the data assessment terms and conditions, and their right to withdraw from the study at any time. Second, participants answered the initial pool of 54 ethics items. All items had to be answered on a 5-point scale with the answering options 1 (I do not agree at all), 2 (I do not agree), 3 (I don't know), 4 (I do agree) and 5 (I agree completely). Finally, participants were asked to answer some demographical questions. The complete procedure took about 20 min. The study received approval from the local ethics committee.

### 2.3. Statistical procedure

The data analysis strategy comprised four steps. First, all responses were examined regarding their psychometric properties like mean, standard deviation, skew, kurtosis, item selectivity and difficulty. No item was excluded because of outliers or extensive skew or kurtosis, etc. Second, the participants' responses were subject to a Principal components analysis (PCA) with Promax rotation to examine whether items can be grouped to clusters. To determine the number of components, the minimum average partial (MAP) test by Velicer (1976) and the Kaiser-Guttman criterion were used. Third, the participants' responses were related to their demographic variables. Then, the resulting questionnaire was administered to a second sample of participants to examine its 3-month test-retest reliability. Finally, a third sample was collected to assess the instruments stability using confirmatory factor analysis (CFA).

## 3. Results

### 3.1. Principle components analysis

The set of 54 items was suitable for computing the PCA, KMO = 0.78, $\chi^2(136) = 940.09$, $p < .001$. The reduction of the initial set of items followed a two-step approach. First, item selectivity (<.50), item difficulty and factor loadings (<.50) were used to delete items. Using these criteria, 31 items were excluded from further analysis. Second, a small number of 5 items was excluded from the final set of items as their content did not match the other items that were associated with the respective component.

Table 1 lists the PCA-components, their associated items including their factor loadings, the amount of variance that is explained by a component and the respective Cronbach's $\alpha$ as a measure of internal reliability. Furthermore, means and standard deviations are reported for each item, the subscales, and the overall score. All items have a mean rating >3, denoting the midpoint of the scale. The items with the highest ratings were part of the data privacy subscale. Please note that the items have been translated into English due to reasons of comprehensibility. We tested the German items only. The final version of the questionnaire comprises 17 items measuring five aspects of a person's ethical position (see Appendix). Based on the results of the subscales, a total score for the general agreement to the instruments ethical perspective can be calculated. Due to the response format of the questionnaire, the range of possible values is between 1.0 and 5.0, whereas 5.0 represents that a person demonstrates a high awareness of ethical conduct.

PCAs using Promax rotation allow for clustering items to components which are still inter-correlated. This implies on the one hand that a person might be highly concerned about one component, while there is only a slight awareness about another component. On the other hand, it has been expected that the components should be significantly correlated with the overall Epos score as the ideal profile of a person being generally and highly concerned with ethics in software development, complies with high values on all scales. Table 2 shows the instrument's subscale correlations for the values obtained in the sample. Most subscales have positive and significant relationships to other subscales and the total score. However, the subscale data privacy does not correlate with the subscales regulation, societal responsibility and company responsibility.

### 3.2. Ethical position by demographic variables

The participants Epos scores were put in context with their demographic variables. Results showed that the ethical position was largely independent of gender (all $|t| < 1.16$, all $p > .24$), the participants' actual interest in ethics (all $|t| < 0.79$, all $p > .43$), and their computer usage behaviour (all $|r| < 0.16$, all $p > .05$).

An analysis of the Epos scores depending on the peoples occupation revealed a significant difference with respect to the subscale regulation, $F(3,136) = 3.38$, $p = .02$. A Scheffé post hoc test showed that the group of employees rated the importance of a legislator's regulatory actions to be significantly more important than the other subgroups.

**Table 1.** Subscales with scale reliability values (Cronbach's alpha). Items with factor loadings, means and standard deviations.

| Item no. | Item | Loading | M | SD |
|---|---|---|---|---|
| *I. Regulation (explained variance = 29.36%, α = 0.87)* | | | *3.21* | *0.65* |
| ET01_14 | Software development should be restricted by ethical regulations if software could harm people. | 0.73 | 3.51 | 1.21 |
| ET01_16 | There should be legally binding ethical regulations that have to be fulfilled in software development. | 0.87 | 3.47 | 1.14 |
| ET01_17 | Governmental mechanisms should control the compliance with ethical regulations in software development. | 0.82 | 3.20 | 1.17 |
| ET01_18[a] | The development of software products does *not* need mandatory ethical standards. | 0.85 | 3.50 | 1.13 |
| ET02_03 | In my opinion software developing companies should be punished for violating ethical regulations. | 0.79 | 3.40 | 1.10 |
| *II. Data privacy (explained variance = 14.50%, α = 0.79)* | | | *4.48* | *0.66* |
| ET02_05 | Users should be able to delete their data that were assessed by software products, at any time. | 0.81 | 4.38 | 0.94 |
| ET02_06 | Users should be able to examine their data that were assessed by software products, at any time. | 0.80 | 4.53 | 0.89 |
| ET02_08 | Data and privacy issues should be considered during software development. | 0.79 | 4.51 | 0.77 |
| ET02_10 | In my opinion software developing companies must adhere to data protection rules. | 0.74 | 4.54 | 0.76 |
| *III. Knowledge (explained variance = 8.71%, α = 0.73)* | | | *3.78* | *0.86* |
| ET01_04 | Software developers should be frequently trained on ethical regulations. | 0.84 | 3.65 | 1.13 |
| ET01_05 | Software developers should be trained on ethical regulations in their education. | 0.73 | 4.03 | 0.99 |
| ET01_06 | Software developers should have permanent access to comprehensive ethics material like books, norms, etc. | 0.80 | 3.69 | 1.05 |
| *IV. Societal responsibility (explained variance = 8.00%, α = 0.71)* | | | *3.93* | *0.80* |
| ET03_03 | Software developing companies should pay attention to the beneficial use of their products for society. | 0.83 | 3.91 | 0.85 |
| ET03_12 | Software developing companies should consider the helpfulness of their products for society. | 0.89 | 3.96 | 0.96 |
| *V. Company responsibility (explained variance = 7.18%, α = 0.62)* | | | *3.47* | *0.79* |
| ET02_16 | Software developing companies should employ ethics representatives. | 0.62 | 3.56 | 1.08 |
| ET03_01 | Employees of a software developing company should not be responsible for controlling the compliance of general ethical guidelines by themselves. | 0.87 | 3.09 | 1.19 |
| ET03_02 | Software developing companies should have employees that take care of ethical issues. | 0.68 | 3.78 | 0.87 |
| *Total (explained variance = 68.10%, α = 0.83)* | | | *3.80* | *0.53* |

α: Cronbach's alpha.
[a]This item is inverted.

**Table 2.** Ethical position subscale correlations.

| | Data privacy | Knowledge | Societal responsibility | Company responsibility | $Epos_{total}$ |
|---|---|---|---|---|---|
| Regulation | .10 | .47** | .34** | .31** | .82** |
| Data privacy | – | .23** | .08*** | .15*** | .46** |
| Knowledge | – | – | .22** | .28** | .70** |
| Societal responsibility | – | – | – | .22** | .50** |
| Company responsibility | – | – | – | – | .59** |

*$p < .01$;
**$p < .001$.

### 3.3. Replication of the factorial structure

To replicate the original factor structure of the Epos questionnaire we gathered a third sample of $N = 196$ participants. As for the test of the instruments reliability, students participated voluntarily and received no incentives. We used their data to compute a CFA. Diagonally weighted least squares (DWLS) was utilised for the CFA. Goodness-of-fit indices included $\chi^2$, goodness-of-fit index (GFI), normed fit index (NFI) and root mean square error of approximation (RMSEA) including the 90% confidence interval. Good model fit was indicated by GFI and NFI of 0.90 or greater and RMSEA of 0.06 or less (Hu and Bentler 1999). When testing the properties of the original factor structure of Epos, the students' responses resulted in an excellent model fit, $\chi^2(120) = 1041.75$, $p < .001$, GFI $= 0.97$, NFI $= 0.94$, RMSEA $= 0.00$, 90% CI $= 0.00–0.00$. However, one item (ET03_02, 'Software developing companies should have employees that take care of ethical issues.') had to be excluded from the analysis because of low correlations ($r < 0.35$) with the other two items of that factor.

## 4. Discussion

The present paper stated that it is necessary to consider ethical aspects in software research and development. Researchers and developers might benefit from instruments like the Epos scale helping them reflecting on ethical issues of their work.

### 4.1. The Epos scale and its psychometric properties

The 17-item Epos instrument assesses the ethical position with respect to one ethical perspective (Tugendhat 1993) on software development. It differentiates the total ethical position score into the five subscales: regulation, data privacy, knowledge, societal and company responsibility. Epos therefore measures a wide range of ethical aspects. Some of the Epos subscales reflect previous research findings. Brandenburg et al. (2017), for example, showed that technology researchers and developers had problems taking care about data privacy issues. Authors concluded that engineers might not have sufficient knowledge about ethical aspects of their work. Landau (2015) articulates the need for governmental regulations to protect privacy in the era of ubiquitous computing, IoT, and smartphones as permanent data loggers. Starting in 2018, the EU's GDPR addresses these data privacy issues.

In addition, Manzeschke (2014) proposed the cube-like MEESTAR model that comprises three perspectives on ethics in technology research and development: the individual level, the organisational level and the societal level. The individual level focuses the

users of technology. The organisational level deals with the organisation providing a technology, and the societal level comprises reflections about the consequences of technology for society, regulations, etc. Epos provides subscales that relate to all three levels. Addressing data privacy and the knowledge of engineers and software developers refer to the individual level, the company responsibility subscale reflects the company level, and the societal responsibility and regulations subscales the societal level.

### 4.2. Possible application of the Epos scale in software development

Using Epos the focus of investigation can be set on the individual employee who develops a new technology, on assessing and comparing members of the same organisation, or on collecting ethical standards of a societal group. On the employee level, Epos is a valuable tool that may increase awareness on ethical issues at a very significant point: Employees are closest to the technology under construction and they have multiple options to implement requirements in different ways. They can decide to choose rather un-/ethical options to engineer, implement and design features of an artefact. On this level, Epos might help managers and group leaders to assess an employee's agreement with the instruments ethical perspective on software development. This process can lead to a re-thinking of ethics also on a company level.

In addition, Epos can be used by companies to gain insights into the need for action. It uncovers the amount of agreement to the Epos subcomponents for a person or a group of persons. Based on this answering profile, one could think of possible countermeasures like workshops or tutorials addressing issues like missing individual knowledge about ethical regulations or best practices in dealing with data privacy. For this purpose, we are working on a version of the instrument that consists of two parts: one part measuring the 'ideal world' from an individual's or a group's point of view and a second part asking for judgments about the ethical status quo in the real world. We believe that the direct comparison of both profiles provides a distinct value for employees and managers.

Academics can use Epos to measure a person's or a group of persons' ethical position at one point in time. Epos scores can be compared between persons or groups of persons. In addition, repeated measurements can help to gain insight in changes in peoples' ethical position over time.

### 4.3. Limitations

Some limitations should be considered when interpreting the presented results. First, the empirical basis builds upon two samples only. Future studies should validate the results by applying the Epos instrument to various samples like programmers, ethicists, the public, etc. Larger and more diverse samples would help to further test the stability of the dimensional structure. Another limitation is that the instrument was built for the domain of software development. Yet, it remains unclear whether it can be adapted to other domains. Future studies should assess its applicability to other contexts as well. In addition, Epos has 17 items which is not much for academic purpose. However, it might turn out that these 17 items are still too many for a company's employees to be used in a regular ethics evaluation. Upcoming research

should therefore focus on Epos' applicability in companies. This would also help to evaluate whether peoples' ethical position regarding software development changes with their occupation. The present study indicated that there might be an effect of occupation on peoples' ethical position. However, a larger sample including diverse occupations should be assessed to answer that research question.

In addition, Epos was developed and tested in German only. The empirical validation of its English translation would tremendously increase the utility of the questionnaire. Furthermore, an empirical study investigating the content validity has to be conducted in the near future. Due to the difficulty to employ questionnaires measuring similar constructs, we will pursue the approach to correlate both, Epos sub-scores and the overall score, with an external criterion. This criterion might be the result of a decision task in which participants have to rate given scenarios illustrating specific ethical issues. Finally, Epos only assesses peoples' agreement with one ethical perspective on ethics in software development. Adopting another ethical perspective, like Utilitarianism, would lead to different items. Epos users first need to decide whether they agree with the instruments perspective. This is in line with Tugendhat's understanding of ethics with people being able to decide whether they want to belong to a group sharing the same understanding of ethical behaviour (Tugendhat 1993).

## 5. Conclusion and final remarks

In this paper, we presented the development of a multidimensional questionnaire that allows for the standardised measurement of an individual's or a groups ethical position. The Epos questionnaire consists of 17 items measuring five different subcomponents. These components cover a comprehensive view of ethics that includes the employee level, the organisational level and the societal level. We believe that the Epos questionnaire is a valuable tool to analyse and reflect one's own ethical position, when developing a new technological artefact. The instrument might help to improve decisions on all three levels. We have found evidence supporting the instrument's quality. However, further improvements and extensions have to be achieved: We are currently working on the validation of an English version of the questionnaire and aim to provide a self-assessment profile that reflects individual strengths and weaknesses with regard to the ethics position in software development.

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## Appendix

**Table A1.** Instruction and German version of the Epos questionnaire.Instruktion: Dieser Fragebogen erfasst Ihre ethische Position in der Softwareentwicklung. Bitte beantworten Sie die Fragen, ohne lange darüber nachzudenken. Es gibt keine richtigen und falschen Antworten, allein Ihre Meinung zählt.

| Item | Ich stimme überhaupt nicht zu | Ich stimme eher nicht zu | Ich weisz es nicht | Ich stimme eher zu | Ich stimme voll zu |
|---|---|---|---|---|---|
| Durch ethische Richtlinien sollte die Entwicklung von Software eingeschränkt werden können, wenn diese zu gefährlich für den Menschen sein könnte. | O | O | O | O | O |
| Es sollte ethische Rahmenbedingungen geben, die gesetzlich vorgeschrieben sind und in der Softwareentwicklung eingehalten werden müssen. | O | O | O | O | O |
| Es sollte staatliche Kontrollmechanismen zur Einhaltung ethischer Richtlinien bei der Softwareentwicklung geben. | O | O | O | O | O |
| Es müssen keine verbindlichen Standards für die ethische Entwicklung von Softwareprodukten etabliert werden.[a] | O | O | O | O | O |
| Ich bin der Meinung, dass softwareentwickelnde Unternehmen Strafen für die Missachtung ethischer Rahmenbedingungen bekommen sollten. | O | O | O | O | O |
| Daten, die während der Nutzung von Softwareprodukten erhobenen werden, sollten jederzeit vom Nutzer löschbar sein. | O | O | O | O | O |
| Daten, die während der Nutzung von Softwareprodukten erhobenen werden, sollten jederzeit vom Nutzer einsehbar sein. | O | O | O | O | O |
| Im Prozess der Softwareentstehung sollte der Datenschutz der Nutzer bereits berücksichtigt werden. | O | O | O | O | O |
| Ich bin der Meinung, dass Datenschutzbestimmungen von softwareentwickelnden Unternehmen eingehalten werden müssen. | O | O | O | O | O |
| Im Rahmen der Softwareentwicklung sollten regelmäszige Schulungen zu ethischen Rahmenbedingungen durchgeführt werden. | O | O | O | O | O |
| In der Ausbildung von Softwareentwicklern sollte grundlegendes Wissen zu ethischen Rahmenbedingungen vermittelt werden. | O | O | O | O | O |
| In der Softwareentwicklung sollten umfassende Materialien, wie z. B. Bücher und Normen zur Orientierung an ethischen Rahmenbedingungen zur Verfügung stehen. | O | O | O | O | O |
| Softwareunternehmen sollten darauf achten, ob ihre Produkte gesellschaftsfördernd eingesetzt werden. | O | O | O | O | O |
| Softwareentwickelnde Unternehmen sollten sich öfter damit befassen, in wieweit ihr Produkt dienlich für die Gesellschaft ist. | O | O | O | O | O |
| In softwareentwickelnden Unternehmen sollte es spezielle Beauftragte für ethische Belange geben. | O | O | O | O | O |
| In softwareentwickelnden Unternehmen sollte nicht jeder Mitarbeiter selbst für die Einhaltung ethischer Richtlinien verantwortlich sein. | O | O | O | O | O |
| In einem Softwareunternehmen sollte es Mitarbeiter geben, die ethische Aufgaben übernehmen. | O | O | O | O | O |

[a]dieses Item ist invertiert.

**Table A2.** English translation of the Epos questionnaire. Please note that the English version of the questionnaire is currently under validation. The presentation is provided for illustration purposes only. Instruction: This questionnaire assesses your ethical position regarding software development. Please answer each of the questions without hesitation. Answers cannot be right or wrong, your opinion counts.

| Item | I do not agree at all | I do not agree | I do not know | I agree | I agree completely |
|---|---|---|---|---|---|
| Software development should be restricted by ethical regulations if software could harm people. | O | O | O | O | O |
| There should be legally binding ethical regulations that have to be fulfilled in software development. | O | O | O | O | O |
| Governmental mechanisms should control the compliance with ethical regulations in software development. | O | O | O | O | O |
| The development of software products does *not* need mandatory ethical standards.[a] | O | O | O | O | O |
| In my opinion software developing companies should be punished for violating ethical regulations. | O | O | O | O | O |
| Users should be able to delete their data that were assessed by software products, at any time. | O | O | O | O | O |
| Users should be able to examine their data that were assessed by software products, at any time. | O | O | O | O | O |
| Data and privacy issues should be considered during software development. | O | O | O | O | O |
| In my opinion software developing companies must adhere to data protection rules. | O | O | O | O | O |
| Software developers should be frequently trained on ethical regulations. | O | O | O | O | O |
| Software developers should be trained on ethical regulations in their education. | O | O | O | O | O |
| Software developers should have permanent access to comprehensive ethics material like books, norms, etc. | O | O | O | O | O |
| Software developing companies should pay attention to the beneficial use of their products for society. | O | O | O | O | O |
| Software developing companies should consider the helpfulness of their products for society. | O | O | O | O | O |
| Software developing companies should employ ethics representatives. | O | O | O | O | O |
| Employees of a software developing company should not be responsible for controlling the compliance of general ethical guidelines by themselves. | O | O | O | O | O |
| Software developing companies should have employees that take care of ethical issues. | O | O | O | O | O |

[a]This item is inverted. Please note that the English version of the questionnaire is currently under validation. The presentation is provided for illustration purposes only.