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Introducing the Privacy Aspect to Systems Thinking Assessment Method

Ron S. Hirschprung¹, Sigal Kordova^{2,*}

¹ Industrial Engineering and Management Department, Faculty of Engineering, Ariel University, Israel.; ronyh@ariel.ac.il

² Industrial Engineering and Management Department, Faculty of Engineering, Ariel University, Israel.; sigalko@ariel.ac.il

* Correspondence: sigalko@ariel.ac.il; Tel.: 972-50-5556400

Abstract: Systems thinking is a valuable skill that may be required for an individual to be promoted in the business arena to managerial or leading positions. Thus, assessing systems thinking skills is an essential transaction for decision-makers in the organization as a preceding step to the promotion decision. One of the well-known and validated tools for this task is a questionnaire. However, because some of the questions invade the employee / candidate's privacy, the answer may be biased. In this paper, we consider this potential bias, a phenomenon that is becoming more and more significant as privacy concerns and awareness continuously increase in the modern digital world. We propose a formal methodology to optimize the questionnaire based on the privacy sensitivity of each question, thereby providing a more reliable assessment. We conducted an empirical study (n=142), and showed that a systems skills questionnaire can be enhanced. This research has a significant contribution to improving the systems skills assessment process in particular, and also lays the foundations for improving the evaluation of other skills / traits.

Keywords: systems thinking, privacy, questionnaire reliability, skills evaluation, systems engineers

1. Introduction

The introduction should briefly place the study in a broad context and highlight why it is important. It should define the purpose of the work and its significance. The current state of the research field should be carefully reviewed and key publications cited. Please highlight controversial and diverging hypotheses when necessary. Finally, briefly mention the main aim of the work and highlight the principal conclusions. As far as possible, please keep the introduction comprehensible to scientists outside your particular field of research. References should be numbered in order of appearance and indicated by a numeral or numerals in square brackets—e.g., [1] or [2,3], or [4–6]. See the end of the document for further details on references.

Most business environments are shaped by technological, social, and economic changes. The contemporary environment is characterized by globalization, fierce inter-organizational competition, adoption of innovative management approaches, the availability of information and knowledge accompanied by rapid and inexpensive media, and cutting-edge information systems. One of the skills required to handle these challenges and requirements is systems thinking [1, 2, 3, 4].

Systems thinking is a concept that reflects thinking about the issue as a whole, emphasizing the interrelationships among its components rather than the components themselves [5, 6]. For example, consider a project of implementing an information-system. One of the project DBA's (Database Administrator) main concerns is how to configure the database in a way that will provide satisfying performances - a purely technical task. However, the project manager has to consider budgets, timeline, manpower, etc..., as well as many technical aspects like the one mentioned above, but not with the detailed resolution as

required from the DBA. The project manager's approach must be based on systems thinking.

Richmond [7] formalized this concept as: "Systems Thinking is the art and science of making reliable inferences about behavior by developing an increasingly deep understanding of underlying structure." Richmond [8] coined the paraphrase "forest thinking" to clarify the concept of systems thinking. According to his approach, forest thinking involves a "view from 10,000 meters rather than focusing on local trees" and "considering how the system influences systems on the other side of the line and how these latter systems influence the former system."

Richmond [9] emphasizes the importance of advancing systems thinking in organizations, and stated that efforts to implement systems thinking need to be focused. We need solutions (at all levels) that address similarities among disciplines rather than differences. Richmond also mentions formal education as an important arena in which we can advance the development of systems thinking. Part of the reason we are so easily becoming "trapped in the specifics" is that we are conditioned via formal education to analyze, separate, and focus on the details of each part. Too little effort is spent in developing people's ability to see the generic – that which persists across disciplinary boundaries. Not enough time is devoted to exercising people's "intuition about the whole."

According to Senge [10], a pioneer of systems thinking in business organizations, a person who can see four levels that operate simultaneously – events, patterns, structures and underlying forces (especially in an organizational setting) – is a good systems thinker. This insight unifies the fields of mental models, shared vision, personal mastery and team learning. It is commonly thought by researchers that performance improvement can be maximized in organizations by applying systems thinking [11]. Numerous organizations use this approach regularly in order to improve their planning and decision-making. However, most organizations have not sufficiently developed their systems thinking because there are insufficient tools available to enhance measurement and training of systems thinking.

Because systems thinking is an interdisciplinary conceptual framework which is used in a wide range of fields rather than a discipline, various studies present how it might be applied to different domains in the global world. These include for example: healthcare [12, 13], education [14, 15], and systems engineering [16, 17, 18]. These studies enable us to better understand the importance of integrating systematic perspective into the working environment of global organizations. Beyond the conceptual foundations of systems thinking, they outline its terminology and tools, as well as the proper ways to use them. Improved understanding of these tools and the new suggested terminology will help in the identification of problems and the design of solutions in an environment which is characterized more and more by the complexity and chaos often associated with global organizations.

Systems thinking is a valuable skill that may be required for an individual to be promoted in the business arena. In the above-mentioned information-systems project example, systems thinking is a prerequisite for the DBA to be promoted to a project manager position, and even to a more senior role, e.g., team manager. This implies that the systems thinking trait is not dichotomic and may be graded with a continuous, or at least a multi-level scale. In order to make a decision regarding promoting / recruiting an employee to a position that requires systems thinking (or a better systems thinking) – a validated and reliable systems thinking estimation tool is required. Moreover, every organization is interested in filling positions that fulfill requirements and in matching the right employee to the right job. In order to evaluate the individual's capabilities in general and to assess his preference for dealing with positions that require systems thinking in particular, we need a validated and reliable tool. Such a tool is essential in the screening and decision-making processes regarding the placing of employees. In this study, we use a well-known tool that was developed by Frank [19], aimed at assessing the individual's interest for positions requiring systems thinking. Frank's tool is a questionnaire for assessing systems

thinking skills. The questionnaire was tested and implemented in previous studies to examine its reliability and validity, which included two types of reliability (inter-judges reliability and inter-item consistency reliability) and three types of validity (content validity, contrasted group validity, and construct validity) [20].

A questionnaire is a useful estimation tool when no other means are available, e.g., for a new candidate or an employee that lacks history in the evaluated field. However, because it is answered by the employee / candidate who is not objective, and may also be in a conflict of interest, it may be biased [21]. A bias may be an outcome of many factors, one of them is the privacy aspect. Privacy and security are major increasing concerns in the digital era [22, 23]. Privacy is considered as an essential value to liberal society and the individual's autonomy [24, 25], and is extensively regulated by governments and intra-governmental organizations, e.g., the EU's General Data Protection Regulation (GDPR) [26, 27]. A privacy violation may be raised even from an unexpected source, e.g., a music selection [28], thus privacy awareness is continuously increasing. This phenomenon may result in biasing answers with high privacy sensitivity [29]. One way to address this problem is by anonymization, a method that enables people to answer questions honestly, as demonstrated for example with the sensitive information on sexual orientation [30]. Inherently, anonymization is not applicable when assessing employees or candidates, because by the nature of this process we would like to attach the assessment to an identified individual in a listed level, rather than a statistical level, as with surveys and researches.

In this paper, we consider the privacy aspect when assessing systems thinking of an individual. Being aware of the fact that answers to privacy sensitive questions may be biased, we propose a methodology to optimize the questionnaire, providing a more accurate estimation. We formalize the methodology, and demonstrate its usefulness in an empirical study. The discussion on privacy is almost always conducted from the preserving and protecting point of view. As bad as it sounds, privacy preserving (from the evaluator's point of view) in an evaluation process is a bad idea. We introduce here a novel approach in which we do not seek to protect the individual's privacy, but to increase the reliability of the assessment by suppressing the effects of the privacy concerns.

2. Optimizing Systems Thinking Assessment based on the Privacy Aspect

2.1. Optimization Concept

The assessment of systems thinking skills, as mentioned previously, is based on a questionnaire. Each question consists of two propositions which are actually statements, one of them indicates a systems thinking approach, while the other does not. For example:

- A. When I take care of a product, it is important for me to concentrate on this product, assuming that other engineers will take care of the other parts of the system.
- B. When I take care of a product, it is important for me to see how it functions as a part of the system.

The participant (the assessed individual) has to select the statement according to his preferences, i.e., the one that better describes him. In the above example, answer B indicates a systems thinking approach. Naturally, there are no "correct" or "right" statements (answers), each one is just an indication of a preference. The number of questions answered with a 'systems thinking answer' divided by the total number of the questions, yields the systems thinking grade on a scale of 0 to 1¹ (minimal and maximal systems thinking skills respectively).

¹ In this paper we linearly normalized the grade to a scale of 0 to 100.

The above grade is a measurement that reflects the individual's systems thinking skills. However, the reliability of a measurement is defined by the extent to which it is accurate [31]. Each item (question) in the questionnaire has a degree of privacy sensitivity that may bias the answer, thus the reliability of the questionnaire. The level of privacy sensitivity can be measured by conducting an isolated survey, this time by asking the participant how sensitive the question is, rather than asking to answer it. In this case, there is no concern of bias because of the following reasons: a) The survey is anonymous – note that we seek here to classify the questions and not the individual; b) The participant is not affected by the answer, i.e., there is no privacy violation; and c) This type of survey informs more about the question itself, rather than about the respondent.

Based on the answers to the systems thinking questionnaire, and the privacy sensitivity answers, the accuracy of the systems thinking questionnaire can be increased as follows: First, we define an indicator to measure the reliability of the questionnaire based on testing the inter-item consistency among questions dealing with similar issues (expected to be correlated with one another). We use the most common test score reliability index, Cronbach's alpha (noted as ρ_T), and also known as Tau-equivalent reliability [32]. Then, the questions are classified into subgroups, where each subgroup deals with a similar issue. For example, a question concerning the preference of seeing the 'whole picture of the project', and a question concerning the preference of being aware of tasks that are not under the employee's responsibility, may be classified in the same sub-group. Then, all answers in each subgroup are reordered along the same scale so that answer A indicates systems thinking, thereby enabling data processing such as ρ_T . For each question ρ_T is calculated within the subgroup. A question is considered to be dropped, if: a) Its privacy sensitivity exceeds a predetermined threshold; and b) by dropping the question, ρ_T is increased by another threshold. The rationale behind this methodology is that the questions that meet these criteria, and are decided to be dropped, cause more 'damage' to the accuracy than benefit. The entire process is depicted in Figure 1.

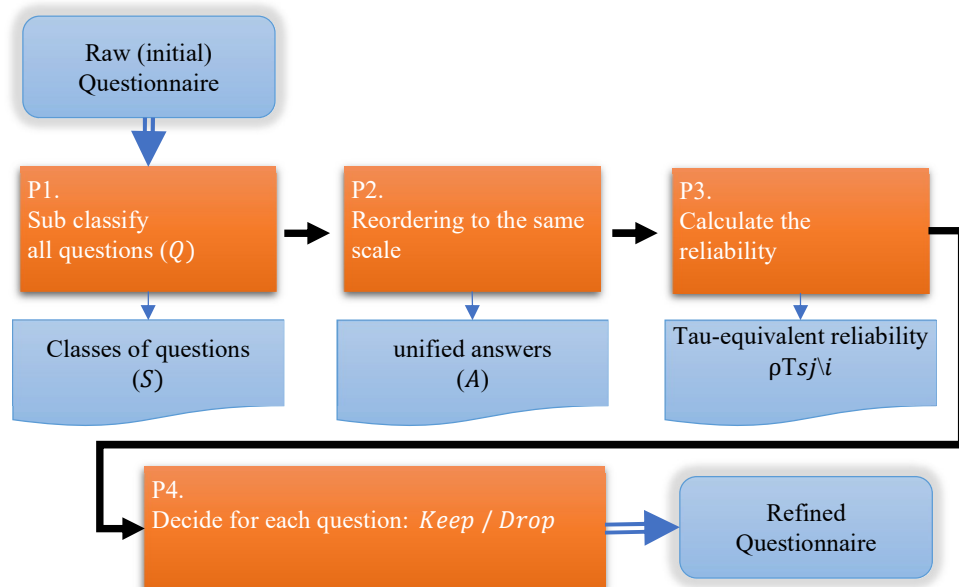


Figure 1. The process of optimizing a systems thinking questionnaire in order to minimize inaccuracies caused by biased answers due to privacy concerns.

2.2. Formal Model

To formalize this methodology, let Q be a set of n questions (q_1, q_2, \dots, q_n) . Let S be a collection of m subsets of questions of the same sub-subject, so that they include all

answers in Q (i.e., $\forall q_i \in Q: (\exists j, k: j \in m, k \in |s_j|, q_i = s_{j,k})$) and each question has a unique appearance over all subsets of S , i.e., $\forall i, j \in m, i \neq j: (\forall t \in s_i: (\nexists u \in s_j: t = u))$.

Now let A_i^j be the answers to question i in s_j ($j \in m, i \in |s_j|$), converted by the function f_c to the same scale, such that $a_i^j = f_c(\text{original } a_i^j)$.

For each subset s_j , the Tau-equivalent reliability ρ_T (Cronbach's alpha) is calculated by equation (1):

$$\rho_{T_{s_j}} = \frac{|s_j|}{|s_j| - 1} \cdot \left(1 - \frac{\sum_{i=1}^{|s_j|} \sigma_{a_i^j}^2}{\sigma_{\sum a_i^j}^2} \right) \quad (1)$$

when $\sigma_{a_i^j}^2$ is the variance of a_i^j , and $\sigma_{\sum a_i^j}^2$ is the variance of $\sum_{i=1}^{|s_j|} a_i^j$.

We note $\rho_{T_{s_j}}^i$ as the Tau-equivalent reliability of subset s_j when question i is dropped. Notice that $\rho_{T_{s_j}}^i$ is a feature of question i and $\rho_{T_{s_j}}$ is a feature of the whole set s_j . Let p_i^j be the privacy concern level of question i in set s_j . We define a question to be sensitive with high concern if $\frac{p_i^j}{p^j} > T_h$, when T_h is a preset threshold. Each question s_j should be decided to be kept or dropped (noted as $include_{s_j}$) according to equation (2):

$$include_{s_j} = \begin{cases} \text{drop} & \left(\frac{p_i^j}{p^j} > T_h \right) \wedge \left(\rho_{T_{s_j}}^i \gg \rho_{T_{s_j}} \right) \\ \text{keep} & \text{otherwise} \end{cases} \quad (2)$$

And the optimized questionnaire defined by equation (3):

$$include_{s_j} = \begin{cases} \text{drop} & \left(\frac{p_i^j}{p^j} > T_h \right) \wedge \left(\rho_{T_{s_j}}^i \gg \rho_{T_{s_j}} \right) \\ \text{keep} & \text{otherwise} \end{cases} \quad (3)$$

3. Empirical study and results

This section describes how we tested the methodology empirically, and provides some estimates on its effectiveness.

3.1. Empirical study

In order to test the methodology, we used a questionnaire for assessing systems thinking skills. The questionnaire was developed and validated by Frank [19], and was also validated by Kordova [33]. As described in section 2.1, each question consists of two propositions which are actually statements, one of them indicates a systems thinking approach, while the other does not. The questionnaire was originally designed for engineers. To adapt the questionnaire to the needs of the current study, the statements were revised to suit a more general population. The modified questionnaire was then distributed to three judges, all experts in the field of industrial engineering and management in general, and particularly in the concept of systems thinking. After analyzing their responses, a

revised validated questionnaire was formulated, comprising 21 sets of duos of propositions. To reduce the tendency of the research subjects to “automatically” choose an answer out of boredom, fatigue, or a lack of motivation without reading the contents of the item in full, the questionnaire was formulated randomly in such a way that systems thinking was sometimes reflected by statements that appeared in sentence A and other times in sentence B.

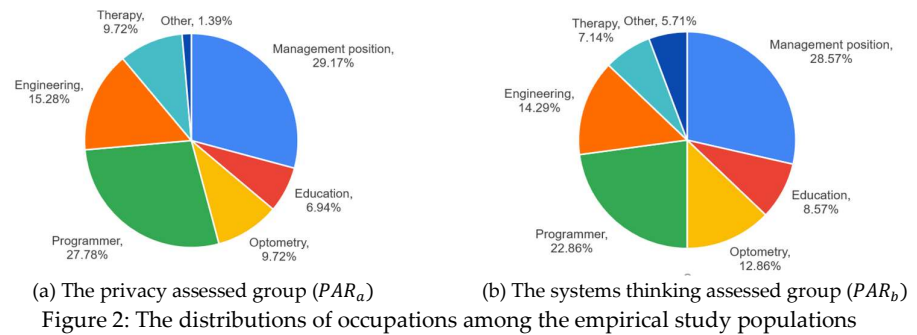
The questionnaire was used in two different ways which we note as actions: *action A*) - To estimate the privacy concern level of each set in the questionnaire. In the context of this action participants were asked, rather than answer the questionnaire, to indicate for each set the privacy sensitivity level on a Likert scale of one to five; and *action B*) - To estimate the systems thinking skills. In the context of this action, participants were asked to answer the questionnaire, i.e., to select one statement in each question that describes them well or represents their preference. The study was authorized by the institutional ethics committee.

3.2. Participants

We conducted an experiment with two different, independent populations. The first population, noted as PAR_a , included $n_a = 72$ participants, and they were purposed to collect the privacy concern level (p_i^j), i.e., to perform *action A*. The second population noted as PAR_b , included $n_b = 70$ participants, and they were purposed to collect the preferences, i.e., to perform *action B*. As mentioned above, PAR_a and PAR_b are disjoint sets ($PAR_a \cap PAR_b = \emptyset$), a necessity required to avoid dependencies that might create internal noise. The participants of PAR_a were asked to perform *action A* only, while the participants of PAR_b were asked to perform *action B* only. When a research subject chose a sentence that gave evidence of systems thinking (in *action B*), one point was awarded; Otherwise, none. The score of the questionnaire for an individual is the sum of points gained, divided by the number of questions. Therefore, the maximum score is 1 (or 100, if normalized to a 0 to 100 scale), which reflects maximal systems thinking skills.

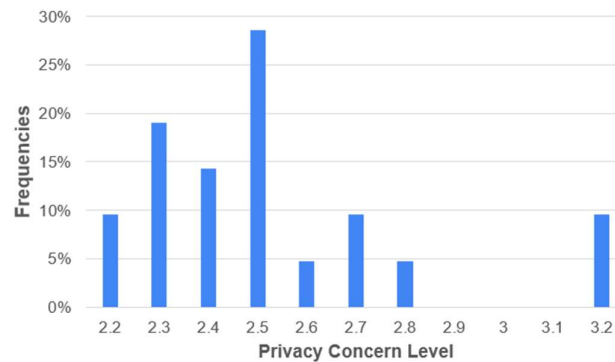
The participants of both groups were recruited among workers in selected industries. Of all the participants in PAR_a : 54% were male and 46% were female. 19% were 18–25 years old, 39% were 26–30 years old, 31% were 31–40 years old, and the remaining 11% were over 40 years old. 89% had gained a bachelor’s degree or higher, 9% had a High School degree, and 2% had no diploma at all. 37% were engineers. All of the participants were employees. Of all the participants in PAR_b : 57% were male and 43% were female. 14% were 18–25 years old, 36% were 26–30 years old, 34% were 31–40 years old, and the remaining 16% were over 40 years old. 86% had gained a bachelor’s degree or higher, 13% had a High School degree, and 1% had no diploma at all. 38% were engineers. All of the participants were employees. The occupation distribution² of PAR_a and PAR_b are depicted in Figure 2(a) and Figure 2(b) respectively.

² In this section of the demography, the actual occupation is reported. For example, if a person is an engineer by his education and works as a manager, he will be reported here as “Management position” rather than “Engineering”. This clarification addresses an alleged inconsistency with the above-reported proportion of engineers among the populations.

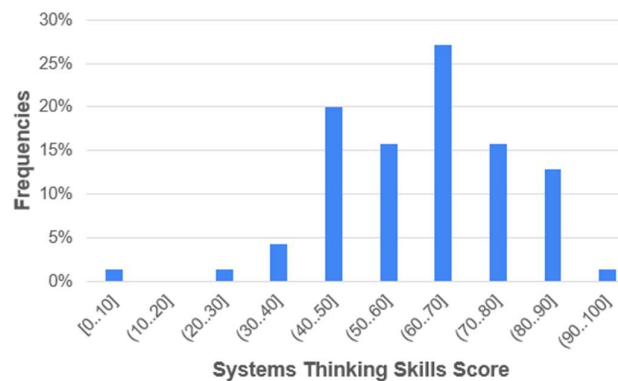


3.3. Results and Analysis

The average privacy concern level (based on PAR_a) for all questions, measured with a scale of one (lowest concern) to five (highest concern) was 2.47 ($\sigma = 0.26$). The distribution of the privacy concern is depicted in Figure 3.



The average systems thinking skills (based on PAR_b) was normalized linearly to a scale of zero (no skills) to 100 (maximal skills), and was 60.6 ($\sigma = 15.23$). The distribution of the systems thinking skills across all participants is depicted in Figure 4. It can be seen that the score of systems thinking skills among all the participants is left-skewed distributed (long left tail). The average score of the systems thinking skills is also located left of the peak. It indicates that the distribution of the score of systems thinking skills of PAR_b is not a normal, and most of the participants are probably systems thinkers in their preferences.



The analysis of the questionnaire of PAR_b included an exploratory factor analysis confirmed by experts according to which two groups of items (subsets of the questionnaire) were identified:

s_1 : included items number: 3, 5, 6, 7, 11, 12, 14, 16, 17, 18, 20.

s_2 : included items number: 1, 2, 4, 8, 9, 10, 13, 15, 19, 21.

The first group (s_1), deals with the preferences of the individual on issues related to interaction of the individual with himself. The second group (s_2), deals with the preferences of the individual on issues related to the individual as part of a group / team / project and also relevant to the concept of leadership and management. Questions in the first group (s_1) included the following: Gaining interdisciplinary and multidisciplinary knowledge, personal preference to focus also on topics that are not core topics, awareness of non-profession related considerations such as business and financial areas. Questions in the second group (s_2) included the following: Familiarity with the project colleagues' responsibilities, being part of a team, which is involved in large projects, involvement in all stages of the project.

In order to optimize the questionnaire, we implemented the process described in Figure 1. and as presented in section 2.1. We used ρ_T as an indicator to measure the reliability of the questionnaire. The value of ρ_T for all the items of the questionnaire or a subgroup (noted as pre- ρ_T) for PAR_b was 0.595. Following stage P4 (in Figure 1), we defined a threshold for the privacy sensitivity of the questionnaire, $T_h = 2.4$. Several items were dropped according to two conditions:

- The average privacy sensitivity of the item exceeded the threshold T_h .
- The value of ρ_T increased by dropping the item

We repeated this process for each of the two groups found in the exploratory factor analysis. The new ρ_T for the partial questionnaire or a subgroup was calculated (noted as post- ρ_T). The results of this process are presented in **Error! Reference source not found..**

Table 1: Pre and Post ρ_T

Group	Items	Threshold	Pre- ρ_T	Items that were dropped	Post- ρ_T
All items (Q)	1-21	2.4	0.595	11, 12, 15, 17-21	0.633
Group 1 (s_1)	3, 5, 6, 7, 11, 12, 14, 16, 17, 18, 20	2.4	0.443	11, 12, 17-20	0.562
Group 2 (s_2)	1, 2, 4, 8, 9, 10, 13, 15, 19, 21	2.4	0.497	15, 19, 21	0.582

The average grade (the assessment of system thinking skills in scale of 0 to 100) of the whole questionnaire (Q), considering all items ($\mu = 60.6, \sigma = 15.3$) was significantly different than the one when questions were dropped ($\mu = 63.7, \sigma = 19.1$); $t(69) = -2.73, p < 0.01$. The average grade of Group 1 questions (s_1), considering all items in the group ($\mu = 52.5, \sigma = 18.7$) was significantly different than the one when questions were dropped ($\mu = 48.3, \sigma = 26.6$); $t(69) = -2.18, p < 0.05$. The average grade of the Group 2 questions (s_2), considering all items in the group ($\mu = 69.6, \sigma = 8.3$) was significantly different than the one when questions were dropped ($\mu = 76.9, \sigma = 8.8$); $t(69) = -6.24, p < 0.01$. In all of the groups, the results indicate a significant change in the assessment of system thinking skills before and after questions were dropped due to privacy sensitivity.

3. Discussion

Systems thinking skills became a necessity when navigating in the modern multi-discipline business environment, mainly when considering managerial roles. However, assessing systems thinking skills is not a trivial task, especially when dealing with a new candidate or when promoting an employee from a position that does not require such skills (thus, no relevant prior knowledge is available) to a new position that requires holistic thinking. A common way to carry out the assessment is by asking the person to be assessed to fill in a questionnaire – a method that is subjected to few obstacles. Since some of the questions may be sensitive from the point of view of privacy concerns, the answers may be biased. Thus, one of these obstacles is the privacy aspect. The awareness of privacy is constantly increasing in the digital era, and privacy protection is supported by researches [34, 35], as well as regulators [36]. Therefore, the impact of privacy concern on the accuracy of system thinking skills is due to become more and more significant. In this paper we address this issue, and propose a methodology to optimize a questionnaire by accommodating the privacy concern parameter in the model. We conducted an empirical experiment ($n = 142$), and showed that the questionnaire can be optimized.

Privacy is usually discussed from the preserving and protecting point of view. Many studies offer methods to protect privacy, e.g., in the data-mining and machine learning processes [37], when applying new technologies like IoT [38], and in the medical field [39]. Privacy protecting is also a significant issue for legislators and regulators, with the most prominent example being the GDPR, the European Global Data Protection [40]. However, while privacy protecting holds many benefits, it may also encapsulate some costs. This study addresses the cost of biasing an assessment process, and seeks to minimize it. While we act here in contrast to the popular direction of privacy protection, this is a legitimate strategy, which acts to the benefit of all sides because of the following: a) It is done with the full consent of the person assessed and the participation is not forced; b) The consequences are clear to the participant; c) Dropping highly-sensitive privacy questions may avoid inconvenience among the participants, and may even increase their privacy.

While this study discusses the optimization of systems thinking skills assessment, the concept that we present here may be adopted, or sometimes even used directly, in other fields. For example, in the education field, as a standardized creativity measurement procedure and developing a tool for creativity assessment [41]. Another example can be found in the human resource management field, for evaluating the relationship between the organizational, culture and leadership behaviour and the job satisfaction of employees [42]. The model is general enough to address other domains, when a few modifications may be required: a) When the participant population is diverse, some refinement might be required to evaluate the privacy sensitivity; b) The metrics vary from one questionnaire to another, and in this case some mathematical adjustments are required; c) Subgrouping is domain dependent, and specific methodologies can be devolved; and d) When the questionnaire is not balanced, i.e., not all questions have the same weight, this parameter must be accommodated in the optimization model. These modifications can be investigated with further research, thereby extending the methodology to other fields.

It is noteworthy that the segmentation into subgroups was made first by exploratory factor analysis and was then confirmed by experts. While this approach is legitimate and proved empirically to yield positive results, other approaches can be proposed in further research. Furthermore, an overlapping between subgroups may be considered, as some questions are expected to indicate high correlations with more than one group.

Another aspect that should be considered is the statistical significance of the assessment tool. Our method is based on omitting sensitive questions, i.e., questions with negative contribution to the calculated index. However, the more questions are included in the questionnaire, the more accurate are the end results. In this view, the questionnaire may be related as a survey, and the number of questions as the sample size, a variable well known to be positively correlated with the evaluation accuracy. This issue can be handled in the early stages of the questionnaire design, when a redundant bulk of

questions is formulated, and then some are dropped, yet a sufficient sample size remains. This approach is the equivalent of the Privacy by Design (PbD) approach [43] but, rather than from the privacy protection point of view as described above, this can be from minimizing the privacy protection costs point of view. Another extension of this research can be made by adopting a more specific level of privacy concerns to an individual or to subgroups of individuals. Privacy concerns vary from one individual to another and can be measured [44]. Thus, instead of applying an average level to the whole population, specific levels can be attached.

This research has a significant contribution to improving the systems skills assessment process in particular, and also lays the foundations for improving the evaluation of other skills / traits. With the growing awareness of privacy, the importance of this method is also due to increase.

References

1. Checkland, P. (1999). Systems thinking. In W. Currie, & B. Galliers, *Rethinking management information systems* (pp. 45-56). Oxford University Press, Oxford.
2. Midgley, G. (2003). *Systems thinking*. Sage London, Thousand Oaks, CA. doi:http://dx.doi.org/10.4135/9781446263556
3. Cabrera, D., Colosi, L., & Lobdell, C. (2008). Systems thinking. *Evaluation and program planning*, 31(3), 299-310. doi:https://doi.org/10.1016/j.evalprogplan.2007.12.001
4. Monat, J. P., & Gannon, T. F. (2018). Applying systems thinking to engineering and design. *Systems*, 6(3), 34. doi:http://dx.doi.org/10.3390/systems6030034
5. Richmond, B., & Peterson, S. (2001). *An introduction to systems thinking*. High Performance Systems., Incorporated Lebanon, NH.
6. Arnold, R. D., & Wade, J. P. (2015). A definition of systems thinking: A systems approach. *Procedia Computer Science*, 44, 669-678. doi:http://dx.doi.org/10.1016/j.procs.2015.03.050
7. Richmond, B. (1994). System dynamics/systems thinking: Let's just get on with it. *System Dynamics Review*, 10, 165-157. doi:https://doi.org/10.1002/sdr.4260100204
8. Richmond, B. (2000). *The "thinking" in systems thinking: Seven essential skills*. Pegasus Communications.
9. Richmond, B. (1991). *Systems Thinking: Four Key Questions*. High Performance Systems (HPS).
10. Senge, P. M., & others. (1990). *The art and practice of the learning organization*. New York: Doubleday. doi:https://doi.org/10.1002/pfi.4170300510
11. Neil, D. (1997). Managing With Systems Thinking: Making Dynamics Work For You in Business Decision-Making. *Journal of the Market Research Society*, 39(4), 628-630.
12. Kenett, R. S., & Lavi, Y. (2016). Integrated models in healthcare systems. In F. Moti, S. Haim, & K.-K. Sigal, *Systems Thinking: Foundation, Uses and Challenges*. Nova Science Publisher.
13. Leshno, M., & Menachem, Y. (2016). A System Thinking in Medicine and Health Care: Multidisciplinary Team (MDT) approach for Hepatocellular carcinoma (HCC). In F. Moti, H. Shaked, & K.-K. Sigal, *Systems Thinking: Foundation, Uses and Challenges*. Nova Science Publishers.
14. Goldstein, E. (2016). Identity Economics, System Thinking, and Education. In F. Moti, S. Haim, & K.-K. Sigal, *Systems Thinking: Foundation, Uses and Challenges*. Nova Science Publishers.
15. Koral Kordova, S., Frank, M., & Nissel Miller, A. (2018). Systems thinking education—Seeing the forest through the trees. *Systems*, 6(3), 29. doi:http://dx.doi.org/10.3390/systems6030029
16. Davidz, H. L., & Nightingale, D. J. (2008). Enabling systems thinking to accelerate the development of senior systems engineers. *Systems Engineering*, 11(1), 1-14. doi:http://dx.doi.org/10.1002/sys.20081
17. McDermott, T., & Freeman, D. (2016). Systems Thinking in the Systems Engineering Process: New Methods and Tools. In F. Moti, H. Shaked, & K.-K. Sigal, *Systems Thinking: Foundation, Uses and Challenges*. Nova Science Publishers.
18. Zhang, Y. (2016). Dynamic Systems with Multiple Elements. In F. Moti, H. Shaked, K.-K. Sigal, & N. S. Publisher (Ed.), *Systems Thinking: Foundation, Uses and Challenges*
19. Frank, M. (2010). Assessing the interest for systems engineering positions and other engineering positions' required capacity for engineering systems thinking (CEST). *Systems Engineering*, 13(2), 161-174. doi:http://dx.doi.org/10.1002/sys.20140
20. Kordova, S., & Frank, M. (2018). Systems thinking as an engineering language. *American Journal of Systems Science*, 6(1). doi:10.5923/j.ajss.20180601.02
21. Jain, S., Dubey, S., & Jain, S. (2016). Designing and validation of questionnaire. *International dental & medical journal of advanced research*, 2(1). doi:http://dx.doi.org/10.15713/ins.idmjar.39
22. Bo, C., Shen, G., Liu, J., Li, X.-Y., Zhang, Y., & Zhao, F. (2014). Privacy. tag: Privacy concern expressed and respected. *Proceedings of the 12th ACM conference on embedded network sensor systems*, (pp. 163-176). doi:https://doi.org/10.1145/2668332.2668339
23. Anic, I.-D., Budak, J., Rajh, E., Recher, V., Skare, V., & Skrinjaric, B. (2019). Extended model of online privacy concern: what drives consumers' decisions? *Online Information Review*. doi:http://dx.doi.org/10.1108/OIR-10-2017-0281

24. Regan, P. M. (2002). Privacy as a common good in the digital world. *Information, Communication & Society*, 5(3), 382-405. doi:http://dx.doi.org/10.1080/13691180210159328
25. Mokrosinska, D. (2018). Privacy and Autonomy: On Some Misconceptions Concerning the Political Dimensions of Privacy. *Law and Philosophy*, 37(21), 117-143. doi:http://dx.doi.org/10.1007/s10982-017-9307-3
26. Dorraji, S. E., & Barcys, M. (2014). Privacy in digital age: dead or alive?! Regarding the new EU data protection regulations. 4(2), 292-305. doi:http://dx.doi.org/10.13165/ST-14-4-2-05
27. Li, H., Yu, L., & He, W. (2019). The impact of GDPR on global technology development. *Journal of Global Information Technology Management*, 22(1). doi:http://dx.doi.org/10.1080/1097198X.2019.1569186
28. Hirschprung, R. S., & Leshman, O. (2021). Privacy Disclosure by De-Anonymization Using Music Preferences and Selections. *Telematics and Informatics*, 101564. doi:https://doi.org/10.1016/j.tele.2021.101564
29. Redmiles, E. M., Kross, S., & Mazurek, M. L. (2019). How well do my results generalize? comparing security and privacy survey results from mturk, web, and telephone samples. *2019 IEEE Symposium on Security and Privacy (SP)* (pp. 1326-1343). IEEE. doi:http://dx.doi.org/10.1109/SP.2019.00014
30. Robertson, R. E., Tran, F. W., Lewark, L. N., & Epstein, R. (2018). Estimates of non-heterosexual prevalence: The roles of anonymity and privacy in survey methodology. *Archives of sexual behavior*, 47(4), 1069--1084. doi:http://dx.doi.org/10.1007/s10508-017-1044-z
31. Anastasi, A. (1988). *Psychological testing* (6th edition ed.). NY: Macmillan. doi:https://doi.org/10.1177/001316446902900237
32. Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3). doi:http://dx.doi.org/10.1007/BF02310555
33. Koral, K. S., & Frank, M. (2016). Model for Describing the Systems Thinking Factors. In F. Moti, H. Shaked, & K.-K. Sigal, *Systems Thinking: Foundation, Uses, and Challenges*. Nova Science Publishers.
34. Malandrino, D., Petta, A., Scarano, V., Serra, L., Spinelli, R., & Krishnamurthy, B. (2013). Privacy awareness about information leakage: Who knows what about me? *Proceedings of the 12th ACM workshop on Workshop on privacy in the electronic society*. 279-284. doi:http://dx.doi.org/10.1145/2517840.2517868
35. Kani-Zabihi, E., & Helmhout, M. (2011). Increasing service users' privacy awareness by introducing on-line interactive privacy features. *Nordic Conference on Secure IT Systems* (pp. 131-148). Springer. doi:http://dx.doi.org/10.1007/978-3-642-29615-4_10
36. Culnane, C., & Leins, K. (2019). Misconceptions in privacy protection and regulation. *Law Context: A Socio-Legal J.*, 36, 49. doi:http://dx.doi.org/10.26826/law-in-context.v36i2.110
37. Torra, V. (2010). Privacy in Data Mining. In M. Oded, & R. Lior, *Data Mining and Knowledge Discovery Handbook*. doi:https://doi.org/10.1007/978-0-387-09823-4_1
38. Hamza, R., Yan, Z., Muhammad, K., Bellavista, P., & Titouna, F. (2020). A privacy-preserving cryptosystem for IoT E-healthcare. *Information Sciences*, 527, 493-510. doi:http://dx.doi.org/10.1016/j.ins.2019.01.070
39. Li, W., Milletari, F., Xu, D., Rieke, N., Hancox, J., Zhu, W., . . . others. (2019). Privacy-preserving federated brain tumour segmentation. *International Workshop on Machine Learning in Medical Imaging* (pp. 133-141). Springer. doi:http://dx.doi.org/10.1007/978-3-030-32692-0_16
40. European Commission. (2021). *Data protection*. Retrieved from An official website of the European Union: https://ec.europa.eu/info/law/law-topic/data-protection_en
41. Trisnayanti, Y., Khoiri, A., Miterianifa, & Ayu, H. (2019). Development of Torrance test creativity thinking (TTCT) instrument in science learning. *AIP Conference Proceedings*. 2194, p. 020129. AIP Publishing LLC. doi:http://dx.doi.org/10.1063/1.5139861
42. Tsai, Y. (2011). Relationship between organizational culture, leadership behavior and job satisfaction. *BMC health services research*, 11(1), 1-9. doi:http://dx.doi.org/10.1186/1472-6963-11-98
43. Hustinx, P. (2010). Privacy by design: delivering the promises. 3(2), 253--255. doi:http://dx.doi.org/10.1007/s12394-010-0061-z
44. Hirschprung, R., Toch, E., Bolton, F., & Maimon, O. (2016). A methodology for estimating the value of privacy in information disclosure systems. *Computers in Human Behavior*, 61, 443-453. doi:http://dx.doi.org/10.1016/j.chb.2016.03.033