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Q-SORT EVALUATION OF TECHNOLOGY ADOPTION PROPENSITY ITEMS

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Abstract
Focus attention on technology encourages multidirectional studies about the topic. Understanding personal motivations and approaches to accepting new technologies offers a significant contribution to the social knowledge base of technology management. The paper shows a pilot experiment about the Technology Adoption Propensity model. Q-methodology was used to rank the model's statements among higher education students. The results of the pilot sample explored five opinion groups, presenting a more nuanced picture of optimism, proficiency, dependence, and vulnerability of the respondents than a typical index calculation. Q-methodology can be suggested as a supplementary analysis of technology adoption propensity.

Keywords: *technology adoption, Q-methodology, preferences*

1. Introduction

The diffusion of technology or any innovations is a complex problem. Beyond the business consequences, social, cultural, psychological, and other aspects must be affected. From a business viewpoint, the diffusion of a new product or service is the source of revenue, as well as the competition. The mass phenomenon of diffusion provides valuable information for companies in product and service development. Rogers (1995) described innovators, early adopters, early majority, late majority, and laggards as user categories.

Nevertheless, the mass is the sum of the individuals. Rogers's categories can be applied to both individuals and groups. Exploring the motivations behind the decisions to use or refuse a technology and learning the desires and fears is essential to managing technology. Some models in the field focus on personal behavior; others try to connect man and technics in the mirror of a given task or purpose. Isaias and Issa (2015) summarize theories and instruments on the influencing factors of acceptance as quality evaluation models. These models are frequently used for information technologies, but their scope is not limited to these issues. Personal models define behavioral intention, like the theory of reasoned actions (Fishbein, 1967) or the theory of planned behavior (Ajzen, 1991). Attitudes, norms, and perceptions influence the intention and can lead to actual behavior.

The technology acceptance model (TAM) focuses on the chain of cognitive, affective, and behavioral responses to technology, influenced by design, social, and other factors. The model was initially defined by Davis (1986) and later extended. The extended models consider influencing factors increasingly; however, they also comes with a more complicated measurement structure. Moreover, the Unified Theory of the Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2013) offers a comprehensive framework using the features of behavioral models as well.

A common limitation of these models is that the evaluation is specifically linked to a selected technology for the analysis. Investigating the general approaches requires different models. Technology Readiness Index (TRI) or Technology Adoption Propensity (TAP) instruments serve this purpose. The paper deals with the TAP but not its original methodology. Q-methodology is used to analyze the relative order of the statements used in the TAP survey. The results can be considered a pilot study based on the responses of higher education students. It aims to explore preliminary patterns of the opinions and to support preparing broader research.

This paper shows a pilot methodological experiment. Since the influencing factors of technology adoption are complex and diverse, the relations between the factors are necessary. Exploring the relative weights through the personal and group level preferences can contribute to a better understanding of the driving forces of technology adoption, and targeted actions can be introduced in any field based on the preferences. The results can be used in shaping educational materials by focusing on the key acceptance factors that lead to a better acceptance of new technologies. Similarly, marketing strategies can be the beneficiaries of the information.

2. Technology adoption propensity instrument

The Technology Adoption Propensity (TAP) instrument and index comprehensively evaluate the individual approaches to technology adoption. However, it is a general instrument compared to other acceptance models; the information provided by exploring the patterns of the opinions may significantly contribute to a better understanding of the technology diffusions.

TAP can be considered a challenger of the Technology Readiness Index (TRI) model developed by Parasuraman (2000). Ratchford and Barnhart (2012) found that some items in TRI are no longer relevant to current technological advancements. The researchers also found that 36 items of the original TRI were enormous, resulting in respondents losing interest and fatigue while answering the questionnaire survey. TAP was developed as a competing approach to TRI with 14 items to measure consumer beliefs and attitudes towards the new technology. It is to be noted that the revised version of the TRI (Parasuraman and Colby, 2015) uses 16 survey items. TAP measures motivator and inhibitor factors defined by Ratchford and Barnhart (2012) as follows:

- Optimism: technology provides a better life. It also refers to how technology enhances the respondent's life rather than how it enhances the lives of generalized others.
- Proficiency: competencies to learn to use new technologies. Considering that performance depends on ability and intentions, proficiency can predict relevant information to the technology developers and the education system to find a focus.
- Dependence: the sense of being overly dependent on technology. Spending too much time with technology, especially info-communication tools, may have a harmful impact on personal life and contacts.
- Vulnerability: technology can lead to harmful impacts and increases distrust in it. The protection against malicious activities needs some skepticism (Ratchford and Barnhart, 2012).

Their publication also includes the TAP items. These are presented as statements for a scale evaluation:

- Technology gives me more control over my daily life (Optimism)
- Technology helps me make necessary changes in my life (Optimism)
- Technology allows me to more easily do the things I want to do at times when I want to do them (Optimism)

- New technologies make my life easier (Optimism)
- I can figure out new high-tech products and services without help from others (Proficiency)
- I seem to have fewer problems than other people in making technology work (Proficiency)
- Other people come to me for advice on new technologies (Proficiency)
- I enjoy figuring out how to use new technologies (Proficiency)
- Technology controls my life more than I control technology (Dependence)
- I feel like I am overly dependent on technology (Dependence)
- The more I use a new technology, the more I become a slave to it (Dependence)
- I must be careful when using technologies because criminals may use the technology to target me (Vulnerability)
- New technology makes it too easy for companies and other people to invade my privacy (Vulnerability)
- I think high-tech companies convince us that we need things that we don't really need (Vulnerability)

Ratchford and Barnhart (2012) and Ratchford and Ratchford (2021) deal with the composition of the TAP index score and the utilization of the model. This study did a different experiment; the detailed description of the calculation was out of the scope.

3. Q-methodology

The Q-methodology is a ranking solution of a set of statements to explore typical patterns of opinions. The methodology was developed by Stephenson (1935) for psychological analysis. Nowadays, its usability is broader than psychology or medical sciences; it can be enhanced to management sciences. Q-methodology combines qualitative and quantitative approaches. A questionnaire is used, in which the respondents can express their views by sorting a large number of statements from most agree to most disagree.

Watts and Stenner (2012) compared by-variable factor analysis and the R-methodology with by-person factor analysis and Q-methodology as invert techniques. They emphasized that R and Q cannot be managed by the same surveys; a different approach in survey design must be considered. A usual way with R-methodology is creating factors to make a dimension reduction and then seeking similar opinions by cluster analysis. That way, it uses the distances of the responses, while Q-methodology is initiated from the correlation matrix and groups the statements.

Brown (1980) justified the applicability of the Q-methodology. He emphasized that only a limited number of distinct viewpoints exist on any topic, so Q-samples containing a wide range of existing opinions on the topic will reveal these perspectives. As a result, the Q-methodology can miss the representative sample, and the normal distribution of the responses is incorporated by the forced sort of the participants (Stephenson, 1953).

The data collection method makes the relative opinion of a respondent about every statement concerning all other statements explicit, presenting a holistic order with integrated trade-offs (Zabala and Pascual, 2016). Data collection can be manual or automated with online tools. Traditionally, pre-printed cards show the statements, and a blank pattern is available to sort them. The respondents must arrange the cards. Finally, the researcher records the orders by respondents and summarizes the results in a data matrix. Software solutions provide a step-by-step guide, automated data collection, intermediary data for analysis, and running statistical tests.

According to the methodology, it must be noted that the presentation of the results is unique in some sense. In an oversimplified and non-scientific approach, it is similar to cluster analysis. Once, the grouping focuses on the respondents and not the survey items. The opinion groups are calculated based on the correlations, not the distances as in cluster analysis. Actually, the allocated groups are called factors. Scale values have a technical role; these should not be confused with Likert-scale values or others.

4. Research design

4.1. Research question

The calculation of the TAP index score uses the average value of the TAP factors, and factor scores are also calculated as the average values of the item evaluations. This method provides a comprehensive picture of optimism, proficiency, dependence, and vulnerability but cannot provide an item-level evaluation. Of course, the sample-level average values by survey items are available; they cannot give information about the relative order of the questions. There are two research questions formulated for the study:

- What is the relative order of TAP survey items?
- What are the common and distinguishing questions of the different opinion patterns?

4.2. Survey design

A survey was designed for Q-methodology to answer the research questions. The cards contained the statements of the TAP items. The question for ranking was formulated as „Which statement do you feel is more true for you?”. The results in this paper are based on a voluntary online survey following the structure of Easy-htmlq version 2.0.3. Data processing was supported by Ken-Q Analysis Desktop Edition (KADE) software. The factors were defined by principal component analysis with Varimax rotation for maximizing the sum of the variances of the squared correlations between variables and factors.

4.3. Research sample and limitations

The study is based on a pilot sample of higher education students. Data collection was performed during the spring semester of 2023. There are 93 respondents from the University of Miskolc and the University of Public Service. However, the Q-methodology is a robust way of analysis; the general interpretation is limited due to the sample selection.

5. Results and discussion

5.1. Factor characteristics

The scree plot of the analysis shows eight factors, each with an eigenvalue higher than 1. The run of the graph (Figure 1) suggests 2 or 3 factors. However, the total variances explained are 38% and 49%. The next break in the chart is to find at 5 factors, with 65% total variance explained. For the pilot analysis, the 5-factor solution was selected based on the high eigenvalue and the additional variance explained. 64 of 93 responses have a significant ($p<0.05$) contribution to the factors; the analysis is limited to them.

Factor characteristics are summarized in Table 1. The correlations between the factor scores are low, except for Factor 1 and 5, which was moderate.

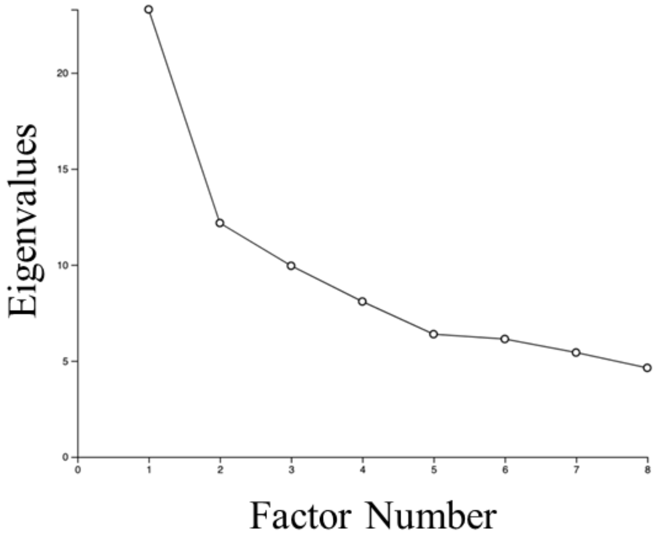

Figure 1. *Scree plot of the factor analysis*

Table 1. *Factors characteristics*

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
No. of defining variables	26	12	6	14	6
Average reliability coefficient	0.8	0.8	0.8	0.8	0.8
Composite reliability	0.990	0.98	0.960	0.982	0.960
Standard error of Factor Z-scores	0.100	0.141	0.200	0.134	0.200
	Correlations between the factors				
Factor 1	-	0.0610	0.1139	0.2133	0.4430
Factor 2	0.0610	-	0.0643	0.1308	-0.2423
Factor 3	0.1139	0.0643	-	-0.1091	0.0386
Factor 4	0.2133	0.1308	-0.1091	-	0.1674
Factor 5	0.4430	-0.2423	0.0386	0.1674	-

Factor scores are presented in Table 2. The order was selected to show the level of consensus on the item. Z-scores give the relative weights of the evaluations. The above rows in Table 2 contain statements with a higher consensus on them between the factors. The ones below are the items disagreed.

Table 2. *Factor scores and statements ranking orders*

Statement	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
	Z-score (Rank)				
...easily do the things...	1,23 (1)	1,43 (1)	0,69 (5)	1,15 (3)	0,4 (7)
...enjoy figuring out...	1,13 (3)	1 (3)	1,83 (1)	0,41 (4)	0,76 (3)
...criminals may use the technology...	0,84 (5)	-0,78 (12)	0,08 (7)	0,22 (8)	0,56 (5)
...fewer problems than other people...	-0,91 (10)	-0,15 (7)	-0,42 (9)	-0,5 (9)	-1,83 (14)
...gives me more control...	-1,45 (14)	-0,42 (10)	-0,57 (10)	-0,91 (12)	0,71 (4)
...make my life easier	0,3 (6)	1,15 (2)	-0,21 (8)	-1,32 (13)	0,49 (6)
...figure out new high-tech...	-1,05 (11)	-0,36 (9)	0,99 (2)	1,17 (2)	0,14 (8)
...become a slave to it	1,15 (2)	-1,41 (13)	-0,7 (11)	0,36 (6)	0 (9)
...people come to me...	-0,34 (9)	0,87 (4)	-1,76 (14)	0,34 (7)	-0,51 (10)
...to invade my privacy	0,29 (7)	0,81 (5)	0,43 (6)	-0,77 (11)	-1,72 (13)
Technology controls my life...	-1,29 (13)	-0,2 (8)	0,97 (3)	-1,71 (14)	-0,84 (12)
...overly dependent on technology	0,23 (8)	-1,95 (14)	0,77 (4)	-0,57 (10)	0,89 (2)
...high-tech companies convince us...	0,98 (4)	-0,49 (11)	-1,33 (13)	0,37 (5)	1,63 (1)
...helps me make necessary changes...	-1,1 (12)	0,49 (6)	-0,78 (12)	1,76 (1)	-0,68 (11)

5.2. Factor visualization

Using the KADE output, Figures 2 to 4 show the order of the statements by factors, with a highlight of the distinguishing statements. The analysis did not find significant consensus statements among the 5 factors.

-2	-1	0	1	2
* Technology controls my life more than I control technology	* I seem to have fewer problems than other people in making	New technologies make my life easier	I enjoy figuring out how to use new technologies	Technology allows me to more easily do the things I want to do at
** ◄ Technology gives me more control over my daily life	** ◄ I can figure out new high-tech products and services	New technology makes it too easy for companies and other people to	** I think high-tech companies convince us that we need	** ► The more I use a new technology, the more I become a slave to it
	Technology helps me make necessary changes in my life	* I feel like I am overly dependent on technology	I must be careful when using technologies because	
		Other people come to me for advice on new technologies		

Legend

- * Distinguishing statement at $P < 0.05$
- ** Distinguishing statement at $P < 0.01$
- ► z-Score for the statement is higher than in all other factors
- ◄ z-Score for the statement is lower than in all other factors
- ☐ Consensus Statements

Figure 2. *Composite Q-sort for Factor 1 with legends (KADE output)*

Factor 2

-2	-1	0	1	2
** ◄ The more I use a new technology, the more I become a slave to it	Technology gives me more control over my daily life	** Technology helps me make necessary changes in my life	I enjoy figuring out how to use new technologies	Technology allows me to more easily do the things I want to do at
** ◄ I feel like I am overly dependent on technology	** I think high-tech companies convince us that we need	I seem to have fewer problems than other people in making	** ► Other people come to me for advice on new technologies	** ► New technologies make my life easier
	** ◄ I must be careful when using technologies because	** Technology controls my life more than I control technology	New technology makes it too easy for companies and other people to	
		* I can figure out new high-tech products and services		

Factor 3

-2	-1	0	1	2
** ◄ I think high-tech companies convince us that we need	Technology gives me more control over my daily life	New technology makes it too easy for companies and other people to	** ► Technology controls my life more than I control technology	** ► I enjoy figuring out how to use new technologies
** ◄ Other people come to me for advice on new technologies	* The more I use a new technology, the more I become a slave to it	I must be careful when using technologies because	I feel like I am overly dependent on technology	I can figure out new high-tech products and services
	Technology helps me make necessary changes in my life	* New technologies make my life easier	Technology allows me to more easily do the things I want to do at	
		I seem to have fewer problems than other people in making		

Figure 3. *Composite Q-sort for Factor 2 and Factor 3 (KADE output)*

Factor 4

-2	-1	0	1	2
** ◄ New technologies make my life easier	** I feel like I am overly dependent on technology	The more I use a new technology, the more I become a slave to it	Technology allows me to more easily do the things I want to do at	** ► Technology helps me make necessary changes in my life
* ◄ Technology controls my life more than I control technology	** New technology makes it too easy for companies and other people to	** Other people come to me for advice on new technologies	I enjoy figuring out how to use new technologies	I can figure out new high-tech products and services
	Technology gives me more control over my daily life	I must be careful when using technologies because	** I think high-tech companies convince us that we need	
		I seem to have fewer problems than other people in making		

Factor 5

-2	-1	0	1	2
** ◄ New technology makes it too easy for companies and other people to	Other people come to me for advice on new technologies	New technologies make my life easier	I enjoy figuring out how to use new technologies	** ► I think high-tech companies convince us that we need
** ◄ I seem to have fewer problems than other people in making	Technology helps me make necessary changes in my life	Technology allows me to more easily do the things I want to do at	** ► Technology gives me more control over my daily life	I feel like I am overly dependent on technology
	* Technology controls my life more than I control technology	* I can figure out new high-tech products and services	I must be careful when using technologies because	
		The more I use a new technology, the more I become a slave to it		

Figure 4. *Composite Q-sort for Factor 4 and Factor 5 (KADE output)*

5.3. Ranking by the TAP factors

Although the analysis used a limited number of statements, the interpretations of the five factors are still difficult. Translating back the results to the original TAP factors allows a simplified picture. Former studies (Abdul Wahi and Berényi, 2023; Berényi et al., 2021) using the original methodology of TAP index calculations found a high level of optimism and proficiency among higher education students. According to proficiency, the analysis of variance found significant differences about it by gender, age, or study level. Based on the self-assessments, males are more proficient than females. Dependence was around the medium value, while vulnerability was low (the TAP index calculation uses reverse scoring for the inhibitor factors). Due to the scoring method, some information remains hidden. However, the results of the different methods are not directly comparable; the Q-methodology suggests a more nuanced picture (Figure 5).

Factor 1

-2	*-1*	*0*	*1*	*2*
Dependence	Proficiency	Optimism	Proficiency	Optimism
Optimism	Proficiency	Vulnerability	Vulnerability	Dependence
	Optimism	Dependence	Vulnerability	
		Proficiency		

Factor 2

-2	*-1*	*0*	*1*	*2*
Dependence	Optimism	Optimism	Proficiency	Optimism
Dependence	Vulnerability	Proficiency	Proficiency	Optimism
	Vulnerability	Dependence	Vulnerability	
		Proficiency		

Factor 3

-2	*-1*	*0*	*1*	*2*
Vulnerability	Optimism	Vulnerability	Dependence	Proficiency
Proficiency	Dependence	Vulnerability	Dependence	Proficiency
	Optimism	Optimism	Optimism	
		Proficiency		

Factor 4

-2	*-1*	*0*	*1*	*2*
Optimism	Dependence	Dependence	Optimism	Optimism
Dependence	Vulnerability	Proficiency	Proficiency	Proficiency
	Optimism	Vulnerability	Vulnerability	
		Proficiency		

Factor 5

-2	*-1*	*0*	*1*	*2*
Vulnerability	Proficiency	Optimism	Proficiency	Vulnerability
Proficiency	Optimism	Optimism	Optimism	Dependence
	Dependence	Proficiency	Vulnerability	
		Dependence		

Figure 5. *TAP factors by Q-sort factors*

According to the survey question of whether the statement was more or less characteristic of the respondents, a more scattered picture of the TAP factors can be seen. Some items of optimism are ordered in the less characteristic part in each factor, and in the case of Factor 5 there are no items among the highest evaluations. Optimism was less characteristic in Factor 3 than in others. Proficiency was found on the right side of the evaluation matrix, except for Factor 5. Vulnerability questions have high ratings in most factors. The results do not contradict the traditional evaluations but provide additional information.

6. Conclusions

Accepting the increasing role of technology in our lives, the focus on technology acceptance has appreciated even beyond understanding customer behavior and product development issues. Workplace design and development may be a significant field where technology orientation has a broad impact, including business results, ergonomics, and employee satisfaction. Targeted investigations through path models help to explore the strengths and weak points of a given technology, but these studies are time-consuming and have a limited scope. The general evaluation of technology acceptance may seem oversimplified and superficial; however, it is a great initial point for further investigations.

The paper shows a methodological experiment that used the statements of the Technology Adoption Propensity instrument. The Q-sort evaluation was applied to investigate the relative order of the perception of the factors influencing technology adoption. The study is considered a PILOT study among higher education students, and the research must be enhanced to a broader target audience. Moreover, survey questions can be varied. The approach to how characteristic the statement is for somebody was just one opportunity. A projection to a group of people must be purposeful.

The Q-methodology results do not oppose the traditional way in this study but can reveal new details. The factors explored show different patterns, and there are no significant consensus statements in the 5-factor solution; it is worth highlighting the items with the highest consensus. Within optimism, the respondents agreed the most that technology allows doing things more easily, and within proficiency, the respondents enjoy figuring out new technologies. In addition, being careful to avoid criminals was also among the highest rated. It can be concluded that trust in technology was fundamental, and a healthy precaution was characteristic among the respondents. The lowest consensus statements include two of the three items in the dependence factor (control of technology on life and overly depending on technology). Consensus was also missing according to the role of technology in making the necessary changes in life.

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References

[1] Abdul Wahi, N. S., & Berényi, L. (2023). Applicability of technology adoption propensity instrument for public administration students. *Multidiszciplináris Tudományok: A Miskolci Egyetem Közleménye*, *13*(1), 3–11. **https://doi.org/10.35925/j.multi.2023.1.1**

[2] Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. **https://doi.org/10.1016/0749-5978(91)90020-T**

[3] Berényi, L., Deutsch, N. Pintér, É., Bagó, P., & Nagy-Borsy, V. (2021). Technology Adoption Propensity among Hungarian business students. *European Scientific Journal*, *17*(32), 1–21. **https://doi.org/10.19044/esj.2021.v17n32p1**

[4] Brown, S. R. (1980). *Political subjectivity: Applications of Q methodology in political science*. Yale University Press.

[5] Davis, F. D. (1986). A *technology acceptance model for empirically testing new end-user information systems*: Theory and results (Doctoral dissertation). Available at: **http://web.ffos.hr/oziz/tam/DavisIVenkatesh/Davis_1985_DOKTORAT.pdf** [11.01.2023]

[6] Fishbein, M. (1967). Attitude and the prediction of behavior. In M. Fishbein (Ed.), *Readings in attitude theory and measurement* (pp. 477–492). Wiley.

[7] Isaias, P., and Issa, T. (2016). *High Level Models for Information Systems*. Springer.

[8] Parasuraman, A. (2000). Technology Readiness Index (TRI): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. *Journal of Service Research*, *2*(4), 307–320. **https://doi.org/10.1177/109467050024001**

[9] Parasuraman, A., & Colby, C. L. (2014). An updated and streamlined technology readiness index: TRI 2.0. *Journal of Service Research*, *18*(1), 1–16. **https://doi.org/10.1177/1094670514539730**

[10] Ratchford, M., & Barnhart, M. (2012). Development and validation of the technology adoption propensity (TAP) index. *Journal of Business Research*, *65*(8), 1209–1215. **https://doi.org/10.1016/j.jbusres.2011.07.001**

[11] Ratchford, M., & Barnhart, M. (2021). A cross-category analysis of dispositional drivers of technology adoption. *Journal of Business Research*, 127, 300–311. **https://doi.org/10.1016/j.jbusres.2021.01.037**

[12] Rogers, E. M. (1995). *Diffusion of Innovations*. Free Press.

[13] Stephenson, W. (1935). Correlating Persons instead of tests. *Character and Personality*, 4, 17–24. **https://doi.org/10.1111/j.1467-6494.1935.tb02022.x**

[14] Stephenson, W. (1953). *The study of behavior: Q-technique and its methodology*. University of Chicago Press.

[15] Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478. **https://www.jstor.org/stable/30036540**

[16] Watts, S., & Stenner, P. (2012). *Doing Q Methodological research: Theory, method & interpretation*. SAGE Publications.

[17] Zabala, A., & Pascual, U. (2016). Bootstrapping Q Methodology to Improve the Understanding of Human Perspectives. *PloS ONE*, *11*, e0148087. **https://doi.org/10.1371/journal.pone.0148087**