Lithuanian Journal of Statistics *2011, vol. 50, No 1, pp. 14-22*
Lietuvos statistikos darbai *2011, 50 t., Nr. 1, 14-22 p.*
www.statisticsjournal.lt

AN IMPROVED APPROACH TO THE CONSTRUCT OF VIRTUAL WORK BASED ON ESTONIAN SERVICE SECTOR ORGANISATIONS

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Received: June 2011 Revised: September 2011 Published: November 2011

Abstract. The use of virtual teamwork is still a relatively new field for academic research and, even when researched empirically, case study, interviewing or other small sample approaches are usually used. The aim of the paper is to present an improved construct of virtual work based on the Estonian service sector. The novel and theoretical contributions of the paper stem from presenting the improved approach in a new model that uses virtuality; a comparison is also made between virtuality indices of easy and hard work. The empirical results presented in the paper are based on a sample of 781 respondents from 93 service sector organisations. It was found that the improved index is linked to the initial index but differences between respondent groups are clearer, and the improved index is much more user-friendly than the first virtuality index suggested by the authors.

Keywords: virtual work, construct operationalisation, service organisations, easy work, hard work.

1. Introduction

Organisations have been using teamwork for solving problems and tasks mainly in the past 15 to 20 years. A *team* is a group of individuals who work interdependently for solving problems and accomplishing tasks [14]. The term teleworking has been used since 1973, when Nilles [20] first used the term *telecommunicating* to refer to the possibility of replacing the daily routine of commuting to work with the use of telecommunications [21]. Judging from the number of books and papers published on the subject, virtual teamwork seems to have received most attention from researchers in the past 5–10 years. Virtual teams are "groups of people who work closely together even though they are geographically separated and may reside in different time zones in various parts of the world" and also "cross-functional work-groups brought together to tackle a project for a finite period of time through a combination of technologies [11]". In the developing types of virtual work or virtual teams, "virtuality" (sometimes the term "virtualness" has also been used), e.g. [10], appears to be a useful keyword. Virtuality was initially defined in the context of information technology as "virtual – being on or simulated on a computer or computer network" [17]. Now the notion of virtuality is becoming increasingly recognised in both social sciences and organisation theory [22]. The concept of virtuality (from the communication point of view) can be used for advancing research into virtual teamwork, and a new model for developing the typology of virtual work (including virtual teams) was introduced by the authors of the latest papers [18, 19]. The current paper continues building the construct *virtuality* in the sense of using information and communication technology (ICT) for communicating and relationship building between group members, and we use only our second dataset from the year 2007 because thereafter the questionnaire was amended. Questions regarding virtuality were improved in the second year but merging these with findings from the first year may have caused inaccuracies which we

shall attempt to eliminate in the current analysis. The novel aspect of the paper arises from our aim to approach the formation of the index by establishing a virtuality index for each of the communication channels (in the previous operationalisation tasks, we merged different channels into a single factor at first), to form a general index and to study differences in virtual work between various socio-demographic groups. The chapter on methodology also presents the process of operationalisation. Another novel aspect is that we aim to identify differences of virtual work in the case of easy and hard work tasks (EW and HW respectively), which are differentiated according to respondents' opinions in the questionnaire.

2. Methodology

While Bollen [2] notes that "nearly all measurement in psychology and other social sciences assumes effect indicators" (p. 616), an alternative conceptualisation wherein observable indicators are modelled as the cause of latent constructs has also been offered and investigated [1, 3, 6, 8, 15]. A number of earlier studies exist which strive to compose an indicator measuring an immeasurable concept. Factor analysis has been frequently used for this purpose and, more recently, also structural equations.

Covariance-based (e.g. techniques implemented in statistical packages such as LISREL, Amos, EQS, etc.) and component-based (e.g. PLS) method structural equation modelling (SEM) allow researchers to simultaneously examine measurement and structural models [9], yet researchers tend to focus on the structural model rather than fully consider the relationship between measures and their relevant latent constructs [12]. There is no unanimity in the recent literature on the meaning of "latent variable" and "construct" and whether, and to which extent, these might have the same meaning [23]. Historically, constructs were equated with common factors, and hence are latent variables. According to Cronbach and Meehl (1955) [4], "a construct is some postulated attribute of people, assumed to be reflected in test performance" (p. 283). This viewpoint implies the use of a reflective measurement model, such as that of factor analysis or traditional SEM, where the latent variables generate the observed variables. From this viewpoint, a latent variable is a common factor that operationalises a construct [23].

Operationalisation has become increasingly more complex, various new approaches have emerged; one of them uses a second-order model, which, in principle, means that first-order constructs are formed, and they serve as a basis for second-order constructs.

The four main types of second-order models are derived from the fact that *a)* a first-order construct can have either formative [24] or reflective indicators, and *b)* those first-order constructs can, themselves, be either formative or reflective indicators of an underlying second-order construct. The combination of these possibilities produces the models shown in Figure 2 (Types I-IV) in [12:205]. In this paper, we use Type II model that is a factor model where the second-order factor has first-order factors as formative indicators and the first-order factors themselves have reflective indicators (Type II model is shown in Fig. 1). Such a model might be appropriate for the multidimensional composite construct of non-contingent influence attributions examined by [13].

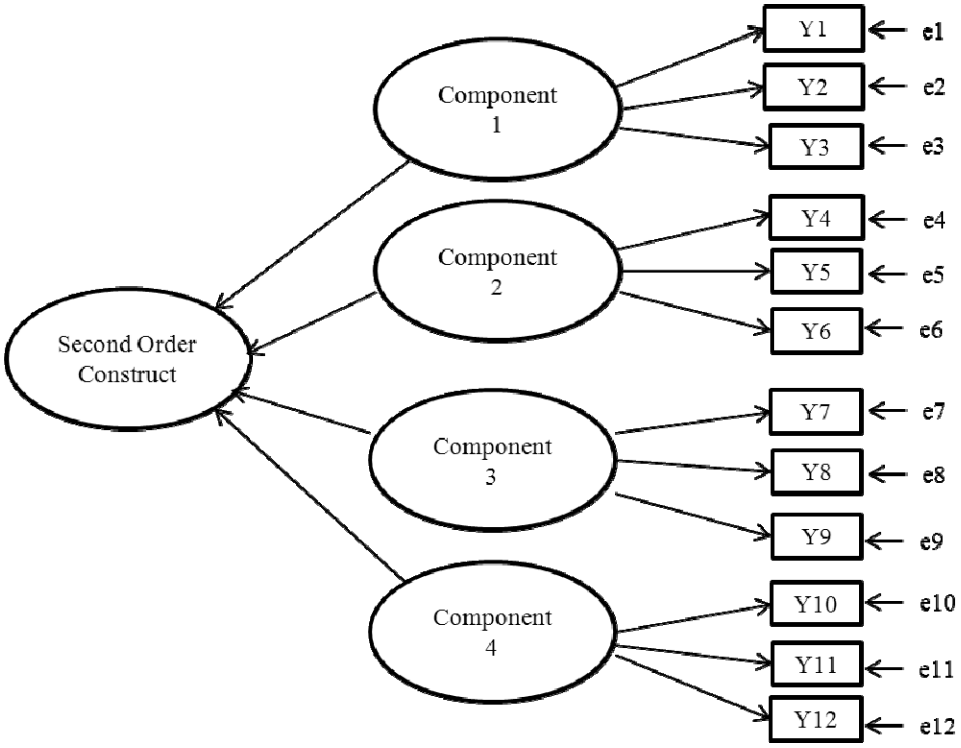

Fig. 1. Theoretical Type II factor model from [13]

The authors have also previously applied similar approaches in an attempt to come up with a virtuality index by first creating three sub-indices with 5-point scales (richness, frequency, and time); then the values of sub-indices were summed up. In case of multiplication, the absent value of 0 of indices would have yielded too many zero results. In our new approach, we decided to study all 8 means of communication and products of sub-indices whereas we distinguished between the means used in easy and hard work tasks. Thus, we formed two independent models; however, essentially, the approach was close to the scheme presented in Fig. 1. In order to merge all eight indices of communication virtuality into a single indicator, we linked them on the basis of "richness" [5], for which we formulated the following logical model (1):

VIRTUALITY = "Formal written"·1 + "Memo's"·2 + "Forum"·3 + "E-mail"·4 + "MSN, Skype"·5 + "Phone"·6 + "Videoconference"·7+ "Face-to-face"·8 (1)

In the model (1), we multiplied richer means of communication by a higher coefficient and less rich means of communication by a smaller coefficient. Rich means of communication have the benefit of enabling users to see the other party, hear the voice, observe body language, etc., while poor means of communication do not have these benefits. In order to compare differences between groups, the analysis of variance (ANOVA), Bonferroni test, pairwise t-test and independent samples t-test were used, and the results were presented in figures and tables.

3. Results

Service sector companies were chosen for the study since they use virtual work more frequently than those in the production sector. Virtual working is more likely to be utilised where intellectual and knowledge-intensive activities are required; it is much more difficult to use virtual work (and teams) in manufacturing – people need to be present for accomplishing the work assignment all the time and usually at the same location of a manufacturing facility [18]. Questionnaire-based research was conducted from February to June 2007. The questionnaire was developed by one of the authors (Mihhailova, G.) as part of her PhD research. Questionnaire research was chosen because it enables a bigger sample (compared to interviewing or case study approach, which are mostly used in this area) and, therefore, more

meaningful conclusions. The sample was random, and the questionnaires were returned directly to the students participating in research in a few weeks or, in some cases, right after receiving and filling them in. The questionnaires were collected from 781 respondents across 93 different service sector organisations. Data was analysed using a statistical program SPSS and MS Excel. The results show that most of the respondents are relatively young and, at the beginning of their career path, almost half of them (46%) have a university degree (Table 1). As regards positions, about half of the respondents (436) are professionals and specialists, while middle-managers and workers are almost equally represented (139 and 154 respectively); 33 top managers have responded, too. Therefore, it can be assumed that the data set is sufficiently representative and the virtuality of different groups may be compared.

Table 1. Sample characteristics

Category		**Number**	**Category**		**Number**
Respondents	Organisations	93	Age (years)	Up to 25	190
	Respondents	781		26–-35	259
Gender	Male	225		36–45	184
	Female	530		46–55	98
	Unanswered	26		Over 55	43
Average length of service (years)	less than 3	322		Unanswered	7
	3–5	113	Education	Tertiary education	360
	6–9	115		Vocational education	217
	10–20	91		Secondary education	170
	more than 20	25		Lower secondary education	19
	Unanswered	115		Unanswered	15

The authors also decided that an overview of initial data through the use of three primary variables included in the index would be useful. The questionnaire contained three separate questions, which covered significance, frequency, and time (the estimated length of time spent on a communication channel per communication event) for both easy and hard work. The first variable was significance, where respondents were asked to note down means of communication in their order of importance in both easy and hard work tasks. The results displayed in Figure 2 show that the least important was video conference, which was preceded by forums. The reason might be that companies have few technical means for video conferencing, and the use of forums requires attending the environment, in other words, being online at all times, and this is quite impossible while at work. In the third place, in terms of the least significant means, were MSN and Skype, which are considered realms for communicating with friends.

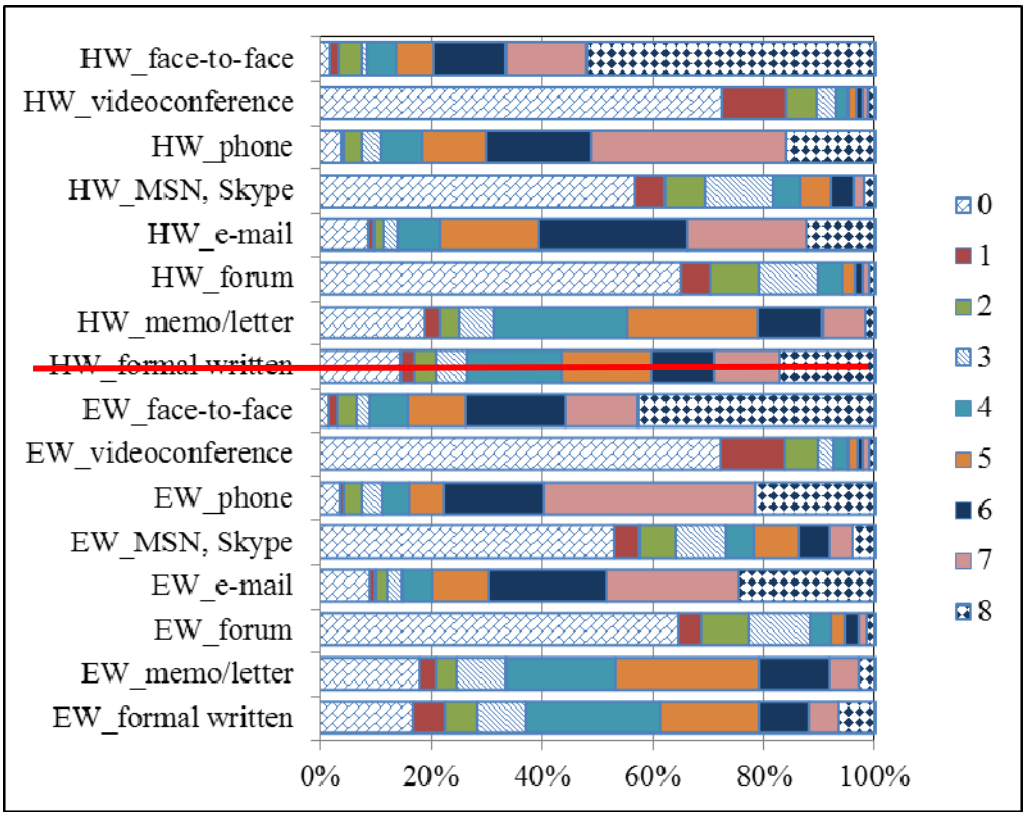

Fig. 2. Significance of means of communication (0 – do not use the means, 1 – do not consider important, ..., 8 – consider very important)

The most important means of communication in service companies is the most accessible one – face-to-face communication – and this applies to both easy and hard work. In the case of easy work, the use of emailing is more frequent and is followed by phone calls, whereas for hard work official/written communication comes out top, closely followed by phoning and emailing. Middle positions (4th and 5th) are taken by memos and letter writing for hard work, while official/written communication was ranked similarly for easy work tasks.

The following two variables were frequency and time (Fig. 3), where similar tendencies emerged – video conference, forum and MSN or Skype were more often valued at 0, that is, they were not used. The most frequent means in both easy and hard work tasks were face-to-face communication, followed by phoning and emailing. The frequency of using memos or written communication was lower rather than higher. As for the length of time, face-to-face communication had the longest period per communication event; in hard work tasks – also written communication. Writing emails and memos took longer more often, and the duration of phone calls was shorter rather than longer.

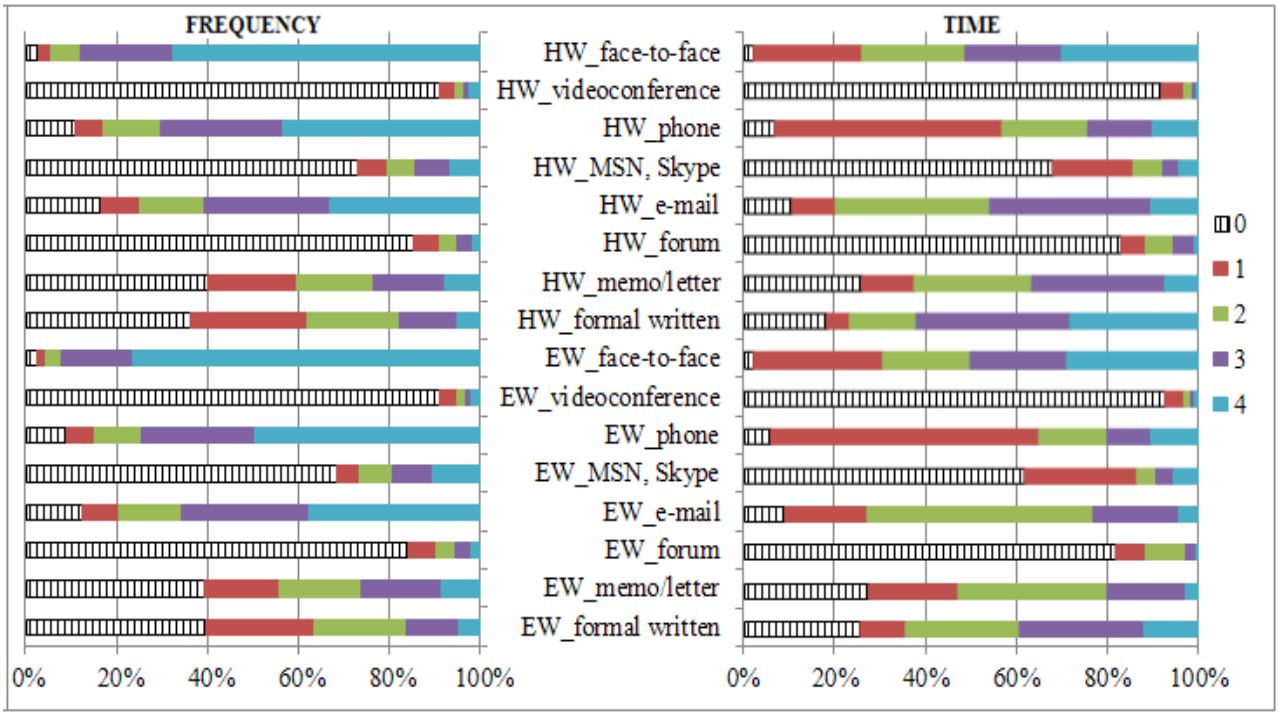

Fig. 3. Frequency of the use of means of communication and duration of each communication event (0 – do not use the means, 1 – use rarely for a short time, ..., 4 – use often/for a very long time)

The next index was virtuality, for which three variables (significance, frequency, and time) of each channel of communication were multiplied and results were merged into one index using the equation presented earlier, which takes into account "richness". The analysis of statistics describing the index derived revealed that the values of six respondents are so much higher (after 3σ-rule) and can be considered outliers; therefore, they were removed from the data set. Findings of the pairwise t-test showed that the average virtuality of easy work ($\bar{x}$ = 837.2, s = 438.8) is statistically of a considerably lower value (p<0,000) as compared to hard work ($\bar{x}$ = 953.0, s = 489.7); their correlation is 0.76, which indicates that those employees who are more virtual when undertaking easy work tasks will behave similarly with hard work tasks and vice versa. By way of explanation, when undertaking more complex work tasks it is probably better to use the "richest" communication channel, that is, face-to-face communication; therefore, higher levels of virtuality are more common in hard work. Histograms demonstrate that variables are of normal distribution.

ANOVA, on the basis of indicators in Table 1, resulted (Table 2) in finding that virtuality of men and women is not statistically significant, even though, on the basis of average men's data, virtuality is slightly higher. As regards the length of service, statistically significant differences ($p < 0.05$) exist between groups in both easy and hard work tasks, whereas in the case of easy work, employees with less than 3 years of service differ significantly ($p < 0.05$) from employees with 10 to 20 years of service, while employees with a shorter period of service display virtuality above average and more, compared to employees with a longer length of service. However, the group with over 20 years of service was smaller than other groups (25 respondents) and the statistical difference did not show clearly; however, a tendency is obvious when average values are compared. Also, in addition to the previous group, employees with 6 to 10 years of service ($p < 0.05$) are statistically significantly different from the group with 10–20 years of service in the case of easy work, while employees with over 20 years of service showed considerably higher virtuality in comparison with those with 10 to 20 years of service; thus, the situation described in easy work does not apply.

Table 2. Results of ANOVA and T-test

Variable		Easy work virtuality			Hard work virtuality		
		N	Mean	Std. deviation	N	Mean	Std. deviation
Gender	Male	223	856.8	458.5	223	973.4	501.0
	Female	527	831.0	432.8	527	950.8	480.9
	Sig.*		0.4635	0.4206		0.5617	0.2826
Age (years)	Up to 25	189	859.6	434.7	189	1011.1	546.6
	26–35	255	875.2	449.4	255	996.1	480.6
	36–45	183	851.0	471.5	183	948.5	480.5
	46–55	98	722.8	377.8	98	794.8	411.7
	More than 55	43	719.6	322.3	43	838.0	412.6
	Total	768	837.4	439.1	768	953.9	490.6
	Sig.*		0.0148			0.0017	
Education	Tertiary	357	791.9	406.1	357	939.9	458.3
	Vocational	216	883.6	435.0	216	978.6	480.5
	Secondary	168	880.7	510.6	168	970.3	564.4
	Lower secondary	19	751.6	369.7	19	806.3	383.9
	Total	760	836.6	440.2	760	954.3	488.2
	Sig.*		0.0357			0.4291	
Occupation	High level manager	32	954.6	481.4	32	1014.3	589.6
	manager	137	811.6	398.6	137	949.4	446.7
	professional	435	833.1	435.6	435	952.4	476.5
	worker	152	827.0	450.2	152	926.9	519.2
	Total	756	833.1	434.1	756	949.4	484.7
	Sig.*		0.4124			0.8218	
Average length of service (years)	less than 3	320	872.8	445.9	320	999.3	502.6
	3–5	111	830.5	453.7	111	934.8	464.7
	6–9	114	852.9	454.5	114	984.3	501.5
	10–20	91	721.7	350.3	91	783.1	359.5
	more than 20	25	672.3	367.6	25	898.6	531.1
	Total	661	833.9	437.0	661	952.3	484.1
	Sig.*		.0157			.0043	

The comparison of age groups (Table 2) showed that there is a statistically significant difference in the case of both easy ($p < 0.05$) and hard work ($p < 0.01$), and it can be generalised that younger people tend to be more virtual, especially when it comes to harder work tasks. A statistically significant difference was established with easy work in the age groups of 26–35 years and 46–55 years ($p < 0.05$) and with hard work; employees of up to 25 years of age also displayed a difference ($p < 0.01$). The levels of education only differed in easy work ($p < 0.05$), and employees with tertiary and secondary education presented a difference ($p < 0.05$), whereas employees with tertiary education displayed lower virtuality compared to other educational groups, except for employees with lower secondary education, of whom there were 19, and this result may be influenced by random effects. No differences were established across positions; however, it should be pointed out that top managers displayed higher virtuality, and virtuality was higher again in hard work tasks than in the easy ones.

4. Conclusions

This overview shows that the list of means of communication in service companies need not include video conference, forum, MSN and Skype facilities; however, ICT advances have been most rapid and findings from four years ago might now be rather different, and thus all means were included in the virtuality index. We made a comparison with the findings of the first index and identified that correlations for easy and hard work tasks were 0.42 and 0.49 respectively, thus showing connections between the two, but a better connection probably was disallowed by joining the two data sets with their slight differences when drawing up the first index. Thus, we can conclude that the new index is more correct than the one derived in the first operationalisation process. Another essential result is that the new index is more convenient to use since its calculation methodology is considerably more user-friendly as three indicators need to be multiplied with all eight communication channels and then combined according to the channel's richness. A way of classification may be suggested which could reduce the number of values on the scale; however, the analysis in the present paper found it more feasible to derive from initial values of the index. The authors aim to study the virtuality index using structural equation models (SEM) in the future as various sources consider this approach an essential methodology for studying latent variables.

References

1. Bollen K. A., Lennox R. 1991: Conventional wisdom on measurement: a structural equation perspective. *Psychological Bulletin,* 110, p. 305–14.
2. Bollen K. A. 2002: Latent variables in psychology and the social sciences. *Annual Review Psychology*, 53, p. 605–34.
3. Cohen P., Cohen J., Teresi J., Marchi M., Velez C. 1990: Problems in the measurement of latent variables in structural equations causal models. *App Psych Measure,* 14, p. 183–96.
4. Cronbach, L. J., Meehl, P. E. 1955: Construct validity in psychological tests. *Psychological Bulletin*, 52, p. 281–302.
5. Daft, R. 1999: *Leadership*. The Dryden Press, 1999 – In: Siimon, A., Türk, K. 2003: *Juhtimine*. Tartu: TÜ Kirjastus, p. 295.
6. Diamantopoulos A., Winklhofer H. M. 2001: Index construction with formative indicators. *J Mark Res*, 38, p. 269–77.
7. Edwards J. R., Bagozzi R. P. 2000: On the nature and direction of relationships between constructs and measures. *Psychological Methods* 5, p. 155–74.
8. Fornell C, Bookstein F. L. 1982: Two structural equation models: LISREL and PLS applied to consumer exit – voice theory. *J Mark Res* 10, p. 440–52.
9. Gefen, D., Staub, D. W., Boudreau, M.-C. 2000: Structural Equation Modelling and Regression: Guidelines for Research Practice. *Communications of the AIS* (4:7), p. 1–79.
10. Griffith, T. L., Meader, D. K. 2004: Prelude to Virtual Groups: Leadership and Technology in Semivirtual Groups. In: Pauleen, D. J. (Ed.). 2004: *Virtual Teams: Projects, Protocols and Processes*, Idea Group, USA.
11. Henry, J. E., Hartzler, M. 1998: Tools for virtual teams. Milwaukeee, Wisconsin: ASQ Quality Press. In: Bal J., Foster P. 2000: Managing the virtual team and controlling effectiveness. *International Journal of Production Research*, Vol. 38, No.17, p. 4019–4032.
12. Jarvis, C. B., MacKenzie, S. B., Podsakoff, P. M. 2003: A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research. *Journal of Consumer Research,* 30, p. 199–218.
13. John, G. 1984: An Empirical Investigation of Some Antecedents of Opportunism in a Marketing Channel. *Journal of Marketing Research*, 21 (August), p. 278–289.
14. Kirkman, B. L. Mathieu, J. E. 2004: The role of virtuality in work team effectiveness. *Best conference paper: Academy of Management Annual meeting*, Louisiana: August 6–11.
15. Law K. S., Wong C., Mobley W. H. 1998: Towards a taxonomy of multidimensional constructs. *Academy of Management Review,* 23, p. 741–55.
16. MacKenzie S. B., Podsakoff P. M., Jarvis C. B. 2005: The problem of measurement model specification in behavioural and organisational research and some recommended solutions. *Journal of Applied Psychology.* 90, p. 710–30.
17. *Merriam-Webster Online Dictionary*, available at: www.merriam-webster.com/ (accessed 12 November 2008).
18. Mihhailova, G., Õun, K., Türk, K. 2009: Virtual work and its challenges and types. *The Business Review*, Cambridge, 2, p. 96–103.
19. Mihhailova, G. Õun K. Türk K. (accepted for publication in May 2011) Virtual work usage and challenges in different service sector branches. *Baltic Journal of Management*.
20. Nilles, J. M. 1988: Traffic reduction by telecommuting: a status review and selected bibliography. *JALA Associates Technical Reports*, 1, No. 2, June.
21. Obra, A. R., Cámara, S. B., Meléndez, A. P. 2002: An analysis of teleworking centres in Spain. *Facilities,* 20, no 11/12 p. 394–399.

22. Shields, R. 2003: *The Virtual, Routledge*, London and New York, NY.
23. Treiblmaier, H., Bentler, P. M., Mair, P. 2011: Formative Constructs Implemented via Common Factors'. *Structural Equation Modelling: A Multidisciplinary Journal*, 18, 1, p. 1–17.
24. Wilcox, J. B., Howell, R. D., Breivik, E. 2008: Questions about formative measurement. *Journal of Business Research* 61, p. 1219–1228.

PATOBULINTA VIRTUALAUS DARBO KONSTRUKCIJA ESTIJOS PASLAUGŲ ĮMONIŲ PAGRINDU

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Santrauka. Virtualaus komandinio darbo naudojimas yra dar nauja mokslinių tyrimų sritis, ir net tada, kai nagrinėjamas atskiras empirinis tyrimas, dažniausiai yra naudojama apklausa ar mažos imties tyrimo metodas. Darbo tikslas yra pateikti patobulintą virtualaus darbo konstrukciją Estijos paslaugų sektoriaus pagrindu. Straipsnio naujumas ir teorinis aprašymas remiasi naujo modelio patobulinimu, kuris naudoja virtualumą, taip pat palyginami lengvo ir sunkaus darbo virtualūs indeksai. Straipsnyje pateikiami empiriniai rezultatai remiantis 781-o atsakytojo imtimi iš 93-ojo paslaugų sektoriaus. Buvo nustatyta, kad patobulintas indeksas yra susijęs su pradiniu indeksu, tačiau skirtumai tarp atsakytojų grupių yra aiškesni ir patobulintas indeksas yra daug patogesnis naudojimui negu pirmasis autorių pasiūlytas virtualus indeksas.

Reikšminiai žodžiai: virtualus darbas, operacijų vykdymo konstrukcija, paslaugų įmonės, lengvas darbas, sunkus darbas.