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ORIGINAL ARTICLE

An online tool to identify white-collar worker profiles in relation to their ICT skills and mental strain

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Abstract The introduction of Internet and Information and communication Technologies (ICT) in offices is a global phenomenon that transformed white-collar worker job demands. Although there are several studies of e-skills and mental workload for central countries, there is a lack of similar studies for the Latin American context. An online snowball sampled ($n = 352$) survey was developed and validated by the authors (internal consistency = 0.7). We characterized ICT worker profiles from *e-skills* and these dimensions: *attitudes* toward, *resources* usage and technology *dependency*. Mental Strain was assessed with raw task load index (RTLX) and correlated with the proposed profiles by means of paired *T*-tests and Mann–Whitney Tests. The sample was characterized by 7.2% of non visual display terminal users and 92.8% of visual display terminal, ICT skilled users. Of the latter, 30.7% were ICT practitioners, 30.4% were ICT Users and 27.2% were E-Business Users. Non VDT users' mental strain was statistically meaningful smaller than VDT–ICT skilled users' mental workload. No statistical differences were found in RTLX results when comparing ICT skilled user profiles. Non VDT users can be identified from ICT skilled Users by their lower ITC Dependency and minor use of ICT resources. There were no differences in those dimensions among ICT skilled Profiles. Attitude toward these technologies was a distinct factor for ICT Users in relation to ICT Practitioners and ITC Business Users. The application of this tool in peripheral and central countries would allow a complete ergonomical characterization of white-collar workers within the Information Society.

Keywords Mental strain · ICT · White-collar work · Peripheral countries

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1 Introduction

We are all quite familiar with the colorful distinction of the different employment sectors. White-collar employment includes salaried professionals and clerical workers and blue–collar employment involves manual labor. Factors that characterize blue-collar employment are decreasing while the average level of qualification is increasing for both blue and white-collar workers (Hemström 2001). The introduction of Internet and Information and communication Technologies (ICT) in offices transformed workspaces, making interpersonal communication and information exchange independents of time and space, and demanding on the individual constant cognitive processing (Wästlund 2007). In this new scenario mental strain analysis is the key for achieving efficiency, wellbeing, satisfaction and safety for white-collar workers.

While there are plenty of mental workload studies in central countries, a revision of recent scientific literature showed little mental strain research for the Latin American context. Muñoz and Martinez (2006) refer only one paper on the topic, focused on the nursery area. Latin America also lacks of normative and development in the impact of its ICT workforce. This paper will bring novel data on this subject.

Cognitive ergonomics takes the concept of stress and strain from a stimulus—organism—response (S–O–R) general model to define mental workload (ISO 1991). From this model, we deduce that the same stimulus (stressor) may lead to different responses (strain) depending on the organism (with their individual characteristics) objectively observable through task performance and assessed with subjective measurements.

To understand this new scenario, two questions have to be answered: (1) Is there a "universal" white-collar worker or can they be grouped in profiles? (2) How important is mental strain in nowadays Latin American ICT workforce?

In order to answer the first question, we define our white–collar worker profiles mainly through their e-skills. Our second question deals with the regional importance of mental strain in white–collar work.

2 Theoretical framework

Previous studies attempted to identify ICT-producing and using sectors (Van Welsum and Vickery 2005). These are generally based on measures of investment in ICT. The Organization for Economic Co-operation and Development (OECD) has a standard definition of the ICT-producing sector, but other definitions exist (Millar 2001).

The OECD definition approved at the OECD Working Party on Indicators for the Information Society (WPIIS) meeting in 1998 was limited itself to industries that facilitate, by electronic means, the processing, transmission and display of information, thus excluding those industries that create and provide the information. Other works undertaken at the OECD (Pilat and Lee 2001) examined empirical evidence on ICT use by industry based on capital flow matrices and capital stock estimates. They found that the largest relative investors in ICT equipment were mainly concentrated in the services sector and in some manufacturing industries.

Another approach (Van Welsum and Vickery 2005) identifies ICT-using sectors by their employment of ICT-skilled personnel, in other words through the degree of actual ICT usage rather than through the investment in ICT capital as in the previous approach. Industries are then ranked according to the degree of the ICT-skills specialization of their workforce, or the share of the industry's 'ICT-skilled employment'. The term 'ICT employment' is interpreted as employment in occupations that use ICT to variable degrees, but across all industries. The focus in this paper is on the latter.

The term "e-skills" is not uniformly applied or understood and is defined in different ways across different studies. The European e-Skills Forum (2004) discussion on e-skills has resulted in definitions for three different types of skill.

(i) *ICT user skills:* the capabilities required for effective application of ICT systems and devices by the individual. ICT users apply systems as tools in support of their own work, which is, in most cases, not ICT. User skills cover the utilization of common generic software tools and the use of specialized tools supporting business functions within industries other than the ICT industry;

(ii) *ICT practitioner skills:* the capabilities required for researching, developing and designing, managing, producing, consulting, marketing and selling, integrating, installing and administrating, maintaining, supporting and the service of ICT systems. ICT practitioners do not only work in the ICT sector. Furthermore, more than half of ICT practitioners work in different types of ICT-support functions in all sectors of the economy (both private and public). Also, ICT practitioners also require ICT user skills in carrying out their work and ICT users can "progress" into ICT practitioner work (Frinking et al. 2005).

(iii) *E-Business skills:* the capabilities needed to exploit opportunities provided by ICT, notably the Internet, to ensure more efficient and effective performance of different types of organizations, to explore possibilities for new ways of conducting business and organizational processes and to establish new businesses.

E-Business skills are said to play an increasingly important role in a company's competitiveness; Basically, ICT skills focus on the question of how to deploy (practitioner) and use (user) ICT, whereas e-business skills focus on the question of what to do with ICT (for an organization).

The OECD (2002, 2004) differentiates three types of ICT skills that cover different domains of e-skills, although some of these overlap:

(i) *Basic skills:* using generic tools like word processors, internet browsers and email clients;

(ii) *Advanced skills:* using advanced and often sector-specific tools for the administration and manipulation of data and digital media;

(iii) *Specialist skills:* Developing, maintaining and operating ICT systems.

Thus, compared to the European e-Skills Forum definitions, ICT user skills have been separated out into basic and advanced, while "specialist" is preferred to "practitioner" for those whose work is fully dedicated to ICT activity for the benefit of others. This study has taken the European e-Skills Forum definitions as the starting point for its analysis.

Although many aspects of ICT Practitioner skills can be tracked through ICT Practitioner occupations, it is not possible for ICT User or e-Business skills (because there are not "ICT user" or "e-Business" occupations). There are, however, occupations that require user or e-business skills. Specific primary research and new surveys involving questions specifically about different aspects of e-skills are required (Frinking et al. 2005).

Our second question deals with the importance of cognitive workload in nowadays' clerical jobs. Terminology in mental workload research has its roots in cognitive and physiological theories. As a result, the terms used are sometimes unclear, as different authors use the same terms with differing meanings. We will stick to O'Donnell and Eggemeier (1986) definition of workload: the portion of the operator's limited capacity that is actually required to perform a particular task.

Workload measurement is the specification of the amount of capacity used. This definition is not task-centered. Mental workload depends upon the demands in relation to the amount of resources the operator is willing or able to allocate and is therefore a relative concept (Meijman and O'Hanlon 1984). Several techniques can estimate the amount of resources required to perform a simple or complex cognitive task and the use of a particular one depends on task nature and research goals. O'Donnell and Eggemeier (1986) specify three workload-measurement groups: subjective (e.g. self-report) measures, performance measures and physiological measures.

Self-report measures have always been very appealing to many researchers. No one is able to provide a more accurate judgment with respect to experienced mental load than the person concerned. Self-report scales have high face validity, are easy to apply and have low costs of application. Critics, on the other hand, say that the source of the resource demands is hard to introspectively diagnose within a dimensional framework. Physical workload and mental workload are, according to the critics, hard to separate (O'Donnell and Eggemeier 1986).

Three frequently used rating scales are the NASA Task Load Index (TLX) (Hart and Staveland 1988), the Subjective Workload Assessment Technique (SWAT) (Reid and Nygren 1988) and the Modified Cooper-Harper scale (MCH) (Wierwille and Casali 1983). The MCH is a one-dimensional scale in which a series of questions directly lead to a single rating.

Both the TLX and the SWAT are multidimensional scales. This means that ratings on several subscales have to be completed. In the end, these ratings can be summarized to obtain an overall workload assessment. The NASA Task Load Index (Hart and Staveland 1988) uses six dimensions to assess mental workload: mental demand, physical demand, temporal demand, performance, effort, and frustration. Twenty step bipolar scales are used to obtain ratings for these dimensions.

A score from 0 to 100 is obtained on each scale. A weighting procedure is used to combine the six individual scale ratings into a global score; this procedure requires a paired comparison task to be performed prior to the workload assessments. NASA TLX has been widely used in applied contexts (Sawin and Scerbo 1995; Alm and Nilsson 1994; Recarte et al. 2008).

Byers et al. (1989) have proposed a Raw Task Load Index (RTLX) that does not require task paired comparison weights. The RTLX is a simple average of the six TLX scales. Byers and his colleagues found that TLX and RTLX had comparable means and standard deviations, and correlated above $r = 0.95$; and they recommend the RTLX as a simple alternative to the TLX.

Performance measures are split into two categories: (i) primary-task performance measures, which are, by its nature, very task-specific. There is not one prevalent primary-task measure, although all primary-task measures are speed or accuracy measures, such as error rate or reaction times. (ii) When another task is added to the primary task, secondary-task measures can be taken and instructions are given to maintain whether the primary or secondary task performance. Most frequently used as secondary tasks are choice reaction-time tasks, time estimation or time-interval production, memory-search tasks and mental arithmetic.

Performance measures have sensitivity limitations: No performance differences between two operators can be determined, even though one can be 'at the limit of his capability', while the other stills has some spare capacity. Self-report methods are capable of detecting those differences.

The last category of workload measures are those derived from the operator's physiology. Different physiological measures have been found to be differentially sensitive to either global arousal or activation level (e.g., pupil diameter), or to be sensitive to specific stages in information processing (e.g., the evoked cortical brain potential). The advantage of physiological responses is that they do not require an overt response by the operator, and most cognitive tasks do not require overt behavior. Moreover, most of the measures can be collected continuously, while measurement is nowadays relatively unobtrusive due to miniaturization. Kramer (1991) mentions as disadvantages of physiological measures the required specialized equipment and technical expertise and the critical signal-to-noise ratios.

Pros and Cons for every approach have been stated. However, the nature itself of our methodology—an online survey—shortens the scope of possible mental workload assessment methods to self-report ones. Comparisons among self-report methods (Rubio et al. 2004; Hill et al. 1992) confirmed NASA TLX desirable values for psychometric properties such as low intrusiveness and implementation requirements on the one hand, and on the other hand high sensitivity, diagnosticity, validity and user acceptance. Also, based on high correlations between 'traditional' TLX (Hart and Staveland 1988) and 'raw' TLX (Byers et al. 1989), we decided to derive the overall workload ratings through the use of the simpler and less time consumer no weighted combination of TLX dimensions.

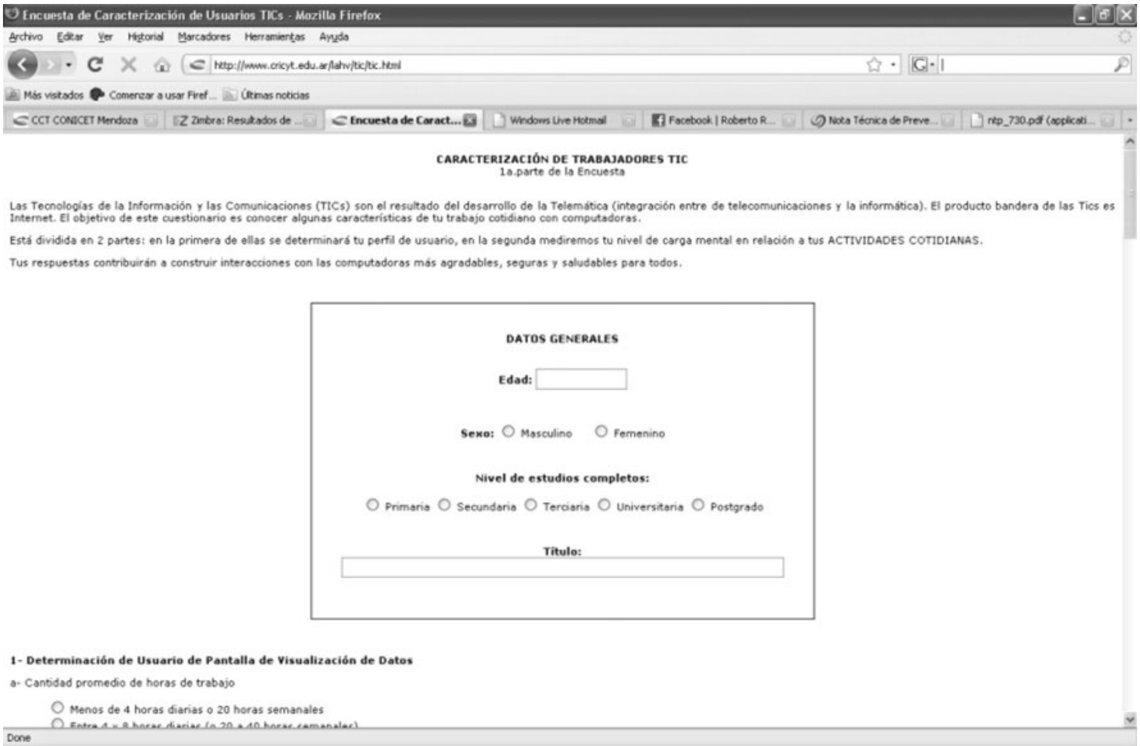

Fig. 1 Online survey main page

3 Materials and methods

The proposed methodology is a survey to identify ICT skilled user profiles (Fig. 1). In order to allow this tool to be fully reproducible, it is still available online at: http://www.cricyt.edu.ar/lahv/tic/tic.html.

The survey has five blocks of information: (i) General Information; (ii) VDT user Determination; (iii) ICT Skills Determination; (iv) Complementary Dimensions; (v) Mental Workload Assessment.

(i) *General Information:* basic demographic data, age, gender and academic formation.

(ii) *VDT user determination* (question 1): based on the 90/270/CEE directive (MTAS 1997). The variables are effective working hours with the VDT (part a, three option—radio button forced choice) and tasks characteristics (part d, checkbox selected seven options list). To be considered a VDT user, one has to work in front of the VDT for more than four hours a day or 20 h a week. If one works between 2 and 4 h a day in front of the VDT, one has to meet at least three of the seven job characteristics displayed in part d to be considered a VDT user.

(iii) *User skills determination:* The variables are the descriptors introduced by the E-skills forum which are user, practitioner and e-commerce skills. Question two lists, in a random order, the e-skills and the survey has to order them from the most to the least important skill required in his daily job. This is achieved with drop-down menus displaying numbers from zero to nine for each skill. If any of the skill is not present, the subjects can choose a zero option.

Punctuation: There are nine skills, three for each profile. The subjects had to rank their skills from the most (nine points) to the least important ones (one point). Then we sum the points to get a score for each kind of skill. We found out in our exploratory analysis that many individuals, as stated Frinking et al. (2005) require the three kinds of skills for their daily tasks.

We propose the following criteria to define user profiles based on e-skills:

ICT User profile: We found out that user skills are constant for almost every user (96% referred to handle this kind of skills) so in order to fit this profile the individual has to refer only user skills, with a minimum score of nine. Other skills might be present but with scores smaller to nine.

ICT Practitioner profile: This group has user skills and also practitioner ones. An ICT practitioner has to have a minimum of nine points in Practitioner skills, no matter his score in User skills, and also his E-commerce skills have to be smaller than the Practitioner ones.

E-Business profile: This group has user skills and also E-Commerce ones. This profile needs to have a minimum of nine points in E-Commerce skills, no matter his score in

User skills, and also his Practitioner Skills have to be smaller than the E-Commerce ones.

(iv) *Complementary dimensions:* three new dimensions were proposed to enrich the profiles, previously based only upon skills. Each dimension has a score that results from the sum of specific items. Each item is a five-point bipolar scale, measuring either positive or negative response to a statement (a lot/nothing). The new variables are ICT attitudes, ICT dependence and use of ICT resources.

ICT attitude is a complex mental state involving beliefs, feelings and dispositions toward ICT. A survey on free software developers showed that 61% of the subjects where motivated by feelings of self creativity, dedicated extra time and lost time perception when programming (Lakhani and Wolf 2005). ICT Dependence refers to the situation when the operator cannot do his job without the ITC and to the presence of Deactivators, random events which may hinder his daily activities. The third dimension is use of ICT resources, the use of new communication channels and new developments of software and hardware.

(v) *Once the profiles were defined*, they were correlated with the individual's self perceived mental workload by means of Raw Task Load Index.

The sampling technique is the network-based method Snowball sampling (Biernacki and Waldorf 1981). Based on the principle of "six degrees of separation" it starts with a set of initial respondents who refer their peers; these in turn refer their peers, and so on.

Snowball sampling is often criticized as a biased form of sampling because selection is non-random. While probability sampling is intended to select a large number of cases that are collectively representative of the population, purposive sampling is typically designed to pick a small number of cases that will yield the most information about a particular phenomenon (Teddlie and Yu 2007).

4 Development of the tool

A draft version of the tool was tested in 29 subjects. Wording was adjusted and some questions were eliminated to narrow the study and shorten completion times. The draft version included an extra dimension, Formation. However, Lemaître (2002) found that the educational measure that has traditionally been used as a skill's proxy is a very partial measure. The skills measure embedded in data on occupations (i) identifies another dimension of skills which is correlated with the educational measure, and (ii) that it holds up independently too. Considering those findings, we decided to drop the Formation dimension.

Skill scoring for profiles determination changed too in this early stage. There are nine skills, three for each profile. In the first version of the survey, the subject had to select only three options but feedback from interviews on participants of the draft version test ($n = 29$) showed disagreement with this method. Some individuals felt that more than three items described their jobs and found hard to choose the best three items. So in the following pilot study, we asked the subjects to rank their skills from the most (nine points) to the least important ones (one point). Then we sum the points to get a score for each kind of skill.

The adjusted tool was sent to a random mailing list which included university students, professors, researchers, clerical workers and technicians. A new sample of 96 individuals was reached. The survey was distributed and completed online. An iterative process (Ledesma et al. 2002) of successive comparisons of items for each dimension in order to maximize the reliability of the test was carried out.

Internal consistence analysis performed by means of Cronbach's Alpha and Pearson linear correlation analyses to avoid information redundancy were performed with Minitab for Windows. The expected results were: (i) a statistical significant low positive Pearson linear correlation among each item of the proposed dimensions and (ii) alpha values around 0.6 and 0.75. Some items were eliminated, wording was adjusted and the survey structure was simplified as a result of this analysis. The best alpha values achieved were 0.7 for attitudes; 0.75 for dependency and 0.6 for resources. In this stage of development, the naming of one dimension changed: the former name for attitudes was attitude. We made this change because from a strictly psychological view, it is not possible to feel attitude toward an inanimate object. Also, we felt that the word 'attitudes' was more suitable for what we were actually asking.

Results are presented: profiles determination and mental workload in relation with the proposed profiles.

5 Results and discussion

Data collection took place between November, 2009 and April, 2010. The "snowball" started with an invitation to participate sent to Universidad Nacional de Cuyo and CCT Mendoza mailing lists. Also further invitations were sent to several ICT and Linux Groups. Even a Facebook event was created. After that, with a weekly frequency, we gathered participant postulations to send invitations. Around a thousand invitations were sent during this period. The final sample reached 352 individuals, with a response rate of around 30%.

The final sample reached 352 individuals. A boxplot analysis of Mental Workload and the proposed dimensions data allowed us to identify outliers (Fig. 2).

As outliers are considered a source of error, they were removed from the sample. Also, individuals older than

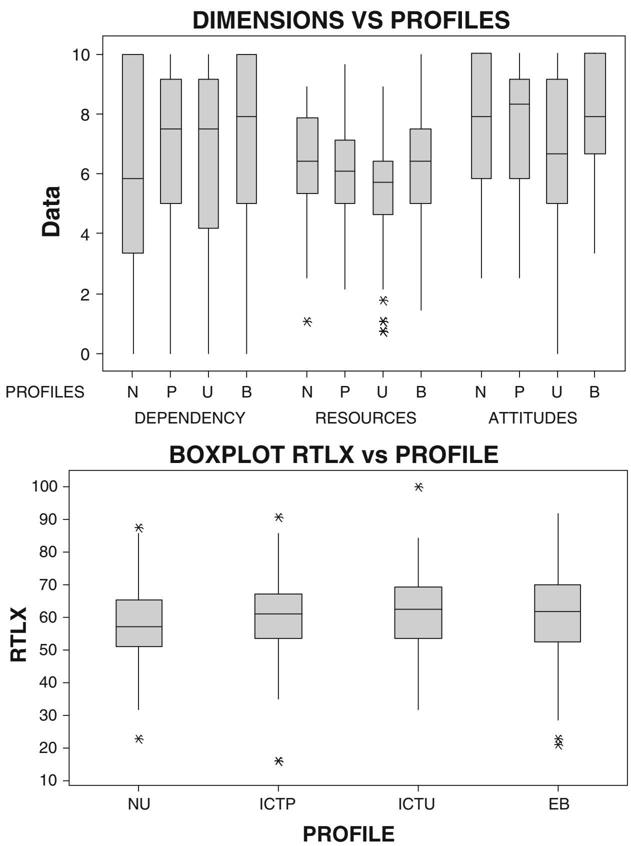

Fig. 2 Boxplot of data

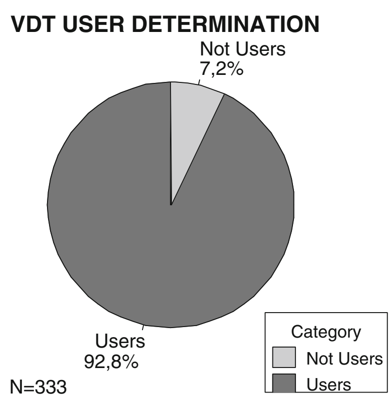

Fig. 3 Pie chart for PVD user distribution

65 years were dropped because their age is beyond economically active population.

The purged sample which was the base of our analysis had 333 subjects. We determined the distribution of VDT users (Fig. 3): 7.2% of non VDT users and 92.8% of VDT users. Non VDT Users were considered as a control group.

This tool defines ICT workers as VDT users with specific ICT skills and a degree of attitude toward, dependence to, and use of ICT resources. We determined the user profiles distribution based on skills (Fig. 4).

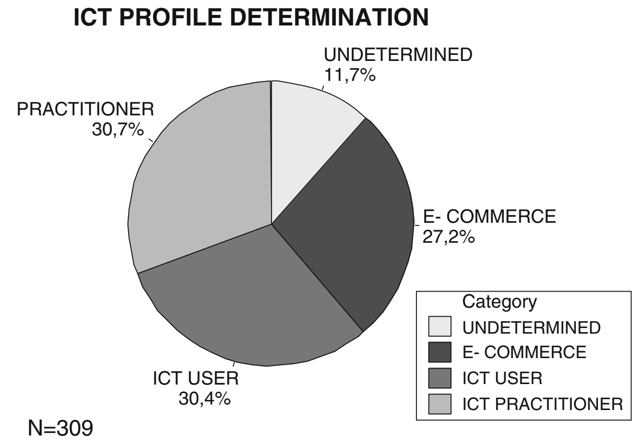

Fig. 4 Pie chart of ICT profiles distribution

There were an 11.7% of users who could not be determined. We believe the cause of this was errors in the completion of the tool, so further mechanisms of control should be implemented. Of those who were able to be characterized, 30.7% were ICT Practitioners (ICTP); 30.4% ICT Users (ITCU) and 27.2% E-Business Users (ICTB).

Our exploratory data analysis continued with descriptive statistics by user profiles. Table 1 shows the means, standard deviations, variances, and minimum and maximum values of the following variables: Age, Dependency, Resources, Attitude and Mental Workload. At this level of analysis, we see that mean ages are around 35 years old. Each profile has a score from zero to ten for the proposed dimensions (Fig. 5): attitude (A), resources (R) and dependence (D). Table 1 also shows the mean score of the dimensions per user profile.

As regards dependency toward ICT, Non Users are the least dependent as could be expected. ICT Users and ICT Practitioners share similar means in this dimension. Finally, E-business skilled users have the higher dependency toward ICT. Non users also have the lowest use of ITC resources available, simply because they are not ICT Users. E-Business skilled users seem to be the profile which takes more benefits from these technologies. The practitioners profile makes a slightly bigger use of ITC resources than the user profile (Fig. 6).

As stated before, the reviewed literature pointed to higher levels of attitude on ICT practitioners. Our data shows high attitude on every group studied, even non users. The more empathic profile is E business users followed by ICT practitioners. ICT users have the least attitude of all, even less than non users.

In relation to Mental Workload, our control group referred less mental workload than the other profiles. This supports our proposal for a change of white–collar job analysis paradigm, from the mainly visual VDT paradigm

Table 1 Variables basic statistics

	Profile	N	Mean	StDev	Variante	Min	Max
Age	UN	24	35.29	9.41	88.56	20	62
	ICT-P	94	34.28	10.13	102.55	22	64
	ICT-U	95	36.62	10.61	112.57	22	61
	ICT-B	84	34.822	8.804	77.519	20	57
Dependency	UN	24	5.487	3.019	9.117	0.8	10
	ICT-P	94	6.906	3.142	9.869	0	10
	ICT-U	95	6.932	2.864	8.205	0	10
	ICT-B	84	7.27	2.633	6.932	0	10
Resources	UN	24	5.407	1.922	3.693	2.5	9.3
	ICT-P	94	6.088	1.697	2.881	2.5	9.6
	ICT-U	95	5.882	1.382	1.911	2.8	8.9
	ICT-B	84	6.3	1.812	3.282	1.4	10
Attitude	UN	24	7.376	2.142	4.59	2.5	10
	ICT-P	94	7.796	2.006	4.024	2.5	10
	ICT-U	95	7.146	2.297	5.278	0	10
	ICT-B	84	7.97	1.712	2.932	3.3	10
RTLX	UN	24	54.9	13.008	171.17	22.5	77.5
	ICT-P	94	60.4	10.33	106.61	35	85.83
	ICT-U	95	62.3	10.64	113.3	31.67	84.17
	ICT-B	84	62	11.76	138.39	33.33	91.67

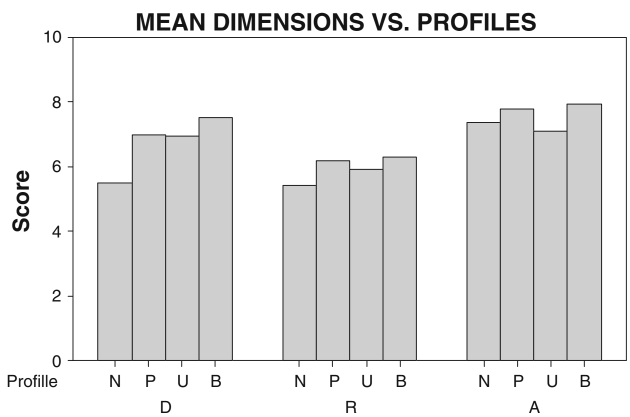

Fig. 5 Bar chart ICT dimensions

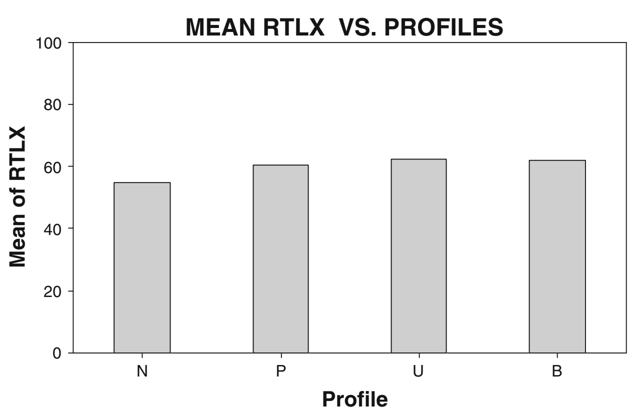

Fig. 6 Bar chart mental strain

to the novel–mental workload focused-ICT paradigm. Among the users, we expected the highest ratings of mental workload in the ICT practitioners profile. However, this profile had lower ratings than ICT users and e-Business skilled users.

In order to continue with our analysis, we had to determine if our variables followed a normal distribution or not. Probability plots for Mental Workload, Dependency, Resources and Attitude let us decide which inferential statistic method suited best for the following analysis.

Besides the plot for visual interpretation, MINITAB delivers an Anderson–Darling Normality Test (AD). If AD's p-value is higher than 0.05, then the variable follows a normal distribution. Our results show that only RTLX values are normally distributed and that the proposed dimensions are not normally distributed. Because RTLX follows a normal distribution (Fig. 7), we will correlate the user profiles and mental workload by means of ANOVA. To find out if our proposed dimensions are useful as a descriptive feature among the profiles formerly based only on skills. We compared the profiles on the basis of each dimension mean score.

As dependency, resources and attitude does not follow a normal distribution and they are nominal variables, they will be correlated with user profiles using Mann–Whitney Test.

Table 2 shows the results of ANOVA for Mental Workload. Non Users were compared with Users and each profile was compared with the others into find out if the different RTLX values observed in the exploratory analysis are statistically different.

P-values below 0.05 make the results statistically meaningful. Each cell shows an interval: If zero is not within that interval (shadowed cells), then there is a difference between the groups compared.

Non PVD users' mental workload is statistically meaningful smaller than ICT users' mental workload. Our

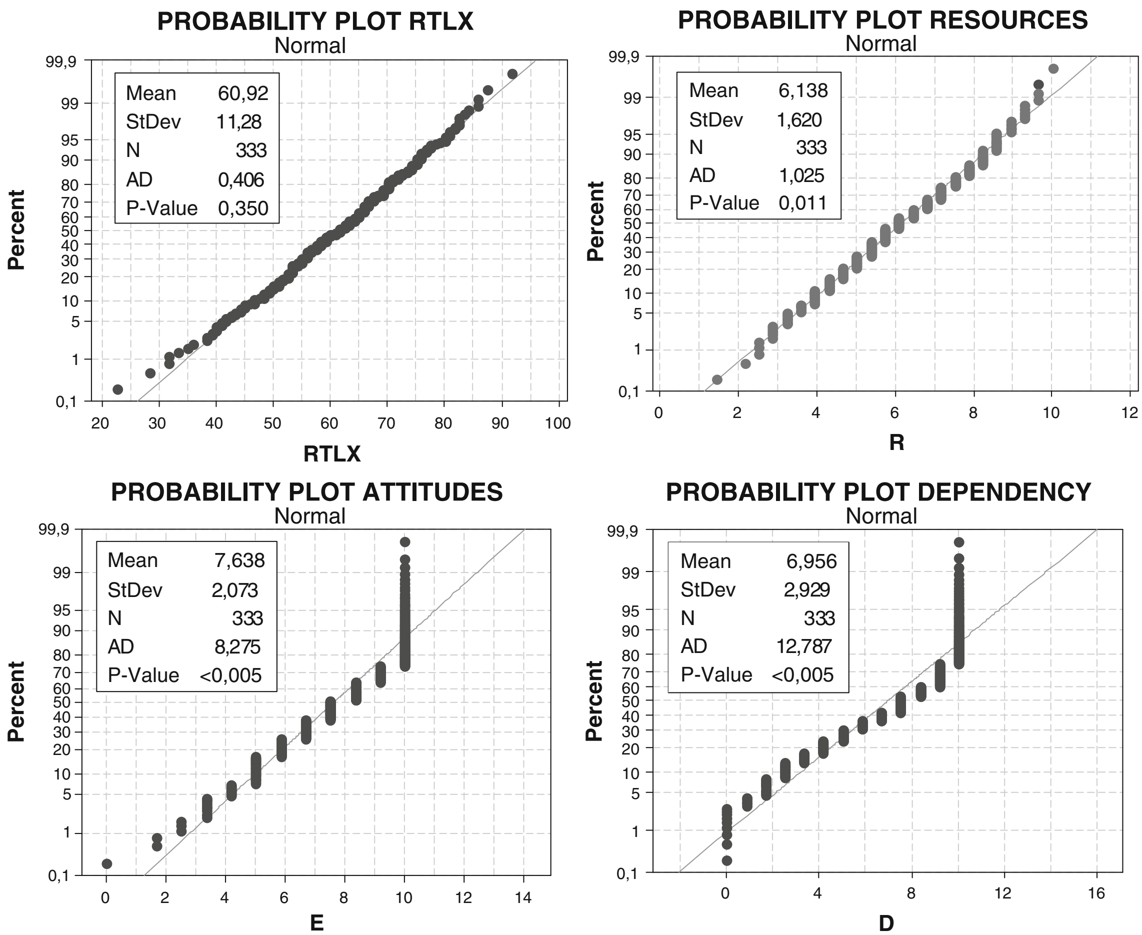

Fig. 7 Probability plot of mental strain and dimensions

Table 2 ANOVA mental strain vs. profiles

RTLX		NU vs. U		
	p-value = *0.004*	(2.16;11.29)		
		ICT-P vs. ICT-U	ITC-P vs. ITC-B	ICT-U vs. ICT-B
	p-value = *0.019*	(–1.18; 5.07)	(–1.62; 4.82)	(–3.56; 2.87)

literature review showed some consequences of the introduction of ICT in white–collar work environments: the reduction of physical demands on clerical jobs and higher cognitive demands on the individual because computers have enabled some of the more routine/repetitive tasks in a job to be taken care of, freeing up time on the individuals for using their mental capacities to carry out more sophisticated tasks, thus needing of constant cognitive processing (Wästlund 2007). Our results are consistent with these concepts.

Comparing RTLX results among ICT user profiles, we found slightly higher values in the ICT Users subgroup and the lowest ratings in the ICT Practitioners group. However, the tendency observed in the descriptive analysis of the data was not present when we run the ANOVA. No statistical differences were found in RTLX results among ICT-P, ICT-U and ICT-B profiles.

An advantage when using a multidimensional mental strain assessment researcher can gather more detailed method such as RTLX is that the information on the sources of the global mental strain score: RTLX uses six dimensions to assess mental workload: mental demand (MD), physical demand (PD), temporal demand (TD), performance (PE), effort (EF), and frustration (FR).

Figure 8 is a bar chart of Mental Strain Dimensions by User Profiles. It is clear that Physical demands are the least important source of workload for all the profiles, followed by Frustration.

The other dimensions share similar levels, but Mental Demands and Effort seem to be more important as mental strain source.

Table 3 shows descriptive statistics for RTLX dimensions by profiles: number of cases (*N*), mean and standard deviation (SD). The lowest score for every dimension is

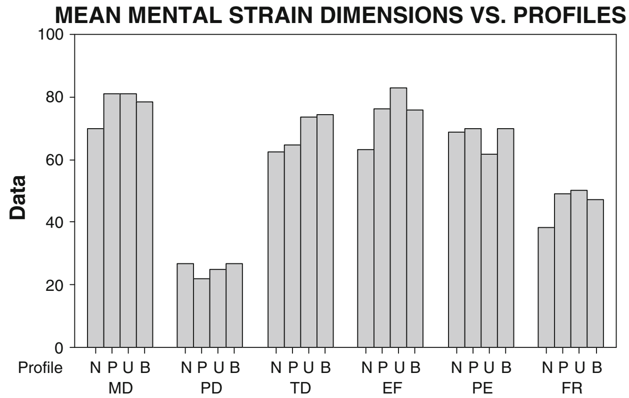

Fig. 8 Bar chart of mental strain dimensions

highlighted in light gray and the highest score is marked in dark gray. Non Users have the lowest levels of mental demands (69.79), temporal demands (62.5), effort (63.33) and frustration (38.33). This profile also has the highest score of physical demands (26.67) and ICT Practitioners have the lowest values of this dimension (21.81). Practitioners also refer having the highest mental demands (81.82) of all groups. ICT Users are characterized by the highest self-perceived effort to perform their daily tasks (82.74) to achieve the best self-perceived performance (61.74).

Finally, ICT business users feel the most time pressure (74.23) and also are the less satisfied with their performance (69.82).

Table 4 shows the results of the Mann–Whitney Tests performed among profiles. The variables analyzed were the proposed dimensions: attitude, use of resources and dependence. For each pair compared, the *p*-value is shown. If *p* is higher than 0.05 (shadowed cells), then there is no difference in that dimension between the pair of profiles compared.

Comparing ICT Non Users and ICT users, we found statistical differences in Dependency.

This was a logical and expected result and a hint that our tool is reliable. ICT Non users should have less dependency on new technologies ICT than ICT users by definition. However when comparing ICT Profiles, we found no differences in this dimension. No matter if the goal for using these technologies rely on administrative (ICT-U), technical (ICT-P) or managerial (ICT-B) duties, it is equally hard to them to do their jobs without a these new technologies.

Non ICT users also benefit less from the possibilities that this technologies offer in terms of communication strategies, as our Resources dimension statistically meaningful results showed. We found no differences in the use of Resources between Non ICT Users and ICT Users.

We have already confirmed that User Skills are the Basic ones and the first step into a more complex ICT usage: ICT users might evolve into ICT Practitioner or ICT business user. Our exploratory analysis of data showed which showed that the ICT Users Profile scored worse than the other profiles in the Resources Dimension. Thus, we tested the idea that acquiring and mastering new e-skills is accompanied by a better usage of ICT Resources. The Mann–Whitney comparison for this dimension showed that there are not statistically significant differences in the usage of ICT resources among profiles, suggesting no relationship between mastering more e-skills and the use of ICT resources.

There is a theoretical idea that ICT make workers more versatile (Lindbeck and Snower 1996). Per se, ICT should lower workers mental strain by sharing more information and establishing quick contacts with colleagues. Indeed, ICT are associated with the feeling of being less isolated and with receiving more help (Hemström 2001).

Then, there should be a correlation between mental strain scores and the use of more communication strategies (ICT Resources Dimension).We tested this hypothesis by means of a correlation analysis. We chose a non parametric method because Resources is not normally distributed.

Table 3 Descriptive statistics mental strain dimensions

	Profile	N	Mean	StDev	StDev	Mean	*N*	Profile	
Mental Demands	UN	24	69.79	24.34	27.45	63.33	24	UN	**Effort**
	ICT-P	94	81.82	18.73	18.38	76.38	94	ICTP	
	ICT-U	95	81.16	20.65	16.83	82.74	95	ICTU	
	ICT-B	84	78.39	21.34	20.61	76.01	84	EB	
Physical Demands	UN	24	26.67	21.09	30.44	68.75	24	UN	**Performance**
	ICTP	94	21.81	19.86	25.16	69.73	94	ICTP	
	ICTU	95	24.74	22.92	30.68	61.74	95	ICTU	
	ICT-B	84	26.61	23.45	26.53	69.82	84	EB	
Temporal Demands	UN	24	62.50	26.21	26.28	38.33	24	UN	**Frustration**
	ICTP	94	64.63	21.98	27.23	48.94	94	ICTP	
	ICTU	95	73.74	21.26	25.39	50.26	95	ICTU	
	ICT-B	84	74.23	22.71	27.95	47.26	84	EB	

Table 4 Mann–Whitney test dimensions

	Attitude	*Resources*	*Dependency*
UN vs. U	0.591	0.051	0.008
ICT-P vs. ICT-U	0.05	0.250	0.753
ICT-P vs. ICT-B	0.728	0.616	0.459
ICT-U vs. ICT-B	0.018	0.105	0.260

A Spearman's Rho correlation value of 0.14 shows a very weak positive correlation between mental strain and the use of ICT resources.

As regards Attitude, there are no meaningful differences between Non Users and User Profiles. ICT Users have statistically significant lower scores than the other two profiles.

Summing up, Non ICT Users can be identified from ICT Users by their lower ITC Dependency and minor use of ICT resources. There are no differences in these dimensions among User Profiles. Attitude toward these technologies is a distinct factor for ICT Users in relation to ICT Practitioners and ITC Business Users.

6 Conclusions

This paper explored the mental strain associated with a global phenomenon: the introduction of ICT in white–collar occupations. Although there are plenty studies on the subject in central countries, Latin America lacks scientific research in mental strain, making this study the first attempt to systematically characterize this growing sector of global workforce, from a cognitive ergonomics perspective.

We developed, validated and implemented a tool to characterize ICT user profiles. This tool defines ICT workers as VDT workers with specific ICT skills and a degree of attitude toward, dependence to, and use of ICT resources. The Internal consistency achieved for the tool after the development phase was satisfactory, with a mean value of Cronbach's alpha of 0.7.

We reached a sample of 352 individuals and performed descriptive and inferential statistics techniques. We compared the data of Non VDT users which was considered as a control group with the data of three ICT user profiles: ICT Practitioners, ICT Users and ICT Business Users. Then, each group was associated with the individual's self perceived mental strain by means of Raw Task Load Index.

Non PVD users' mental workload is statistically meaningful smaller than ICT users' mental workload, confirming that in this new scenario mental strain analysis is the key for achieving efficiency, well-being, satisfaction and safety for white–collar workers.

Assessing mental strain with a multidimensional method let us discriminate the sources of than strain: Non Users have the lowest levels in every dimension considered by RTLX. This group also has the highest score of Physical demands. Practitioners feel the lowest Physical demands and the highest mental demands. In relation to ICT Users, they are characterized by the highest self perceived effort to perform their daily tasks, achieving the worst performance, and resulting in the highest frustration. Finally, ICT business users feel the most time pressure and the most satisfied with their performance.

The results of Mann–Whitney tests for our proposed dimensions led us to a better understanding of ICT worker profiles: Non ICT Users can be identified from ICT Users by their lower ITC Dependency and minor use of ICT Resources. There are no differences in those two dimensions among User Profiles. Attitude toward these technologies is a distinct factor for ICT Users in relation to ICT Practitioners and ITC Business Users.

We presented the results of our tool implemented through a snowball sampled online survey; but it can also be applied in a more traditional, pen and paper way in real workspaces and organizations. Our results are of interest from a descriptive point of view but they also bring novel data as a starting point for comparative analysis. The discussion is open in issues ranging from the digital gap to techno stress. Our goal is to allow an ergonomically complete characterization of white–collar work within the Information Society.

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