



Modular Online Time Use Survey (MOTUS) – Translating an existing method in the 21st century

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Abstract

Time-use surveys are internationally highly valued methods for capturing daily behaviour. Their combination of questionnaires and paper-and-pencil time-diaries (among others in Europe) or telephone interview yesterday-method (in USA) through which respondents (re)construct their daily activities (i.e. what and when) together with contextual information (i.e. with whom and where) is both its strength as well as its weakness. This weakness stems from the high (personnel) costs involved in conducting time-use surveys, costs that can largely be reduced by switching to an online method. However, recent experimenting with online time-use surveys a) jeopardizes the hard work of harmonizing international time-use surveys and b) never truly copied or implemented the methodology of the paper-and-pencil time diaries let alone added additional features that improve the ‘old’ method. After having received a substantial grant we took the challenge to translate this existing method to an online method a) without loosing its strengths, b) with adding additional features that enrich the data even more, and c) with automated processes that reduce personnel and processing costs. In this contribution we a) reveal our method and its modular design and automated processes, b) provide preliminary results of the quality and response of the population pilot study ($n_{invited} \approx 40,000$), c) evaluate our effort, d) challenge others to comment and collaborate on our methodology in order to end up with a (new) standardized methodology for online diary studies that allows cross-national comparisons, and e) reflect on future possibilities and initiatives that serve the imminent online diary methodology.

JEL-Codes: C42, C81, J22

Keywords: Time-use survey, online methodology, time-diary standardization, modular design

1 Introduction

What is time-use research? Answering this question means being aware of the concept of time and its meaning for social life as quoted for example by Szalai in 1972 (p.1): “Many interesting patterns of social life are associated with the temporal distribution of human activities, with the regularities in their timing, duration, frequency, and sequential order”. These elements, i.e., timing, duration, tempo and sequence are often referred to as the parameters of time (Zerubavel 1982) and all data collection techniques that gather information about at least one of these four parameters are referred to as time-use studies.

In general there are three methodological methods to capture daily human behaviour: direct observation, survey research and diary research. The former has been acknowledged to be most accurate method to register ‘real-time’ human activities, albeit not the most functional and reliable one since the registered and observed behaviour is most likely to be influenced by the observer(s). The most frequently used methodology to study human behaviour is the survey method, either by self-report or through an interview. In surveys measuring human practices respondents are retrospectively asked what they have done during a certain period of time (i.e. participation), how often their activities took place (i.e. frequency) and/or how long these activities lasted (i.e. duration). The advantages are a reasonable response in addition to a fairly low field-cost, even for population studies, and the absence of a diary component, which leaves more space for inquiring in depth background questions, albeit the probability of having biased results is higher due to, for example, memory recall-effects and social desirability. In terms of the four parameters of time, survey methodology can only grasp the tempo and/or duration of activities.

Apart from direct observations and survey methodology, time-diary methodology (often referred to as time-use surveys) is capable of capturing all four parameters of time at once and, is therefore, believed to be one of the most profound and valuable ways to capture human behaviour. Time-use surveys draw a picture of how individuals use their time by utilizing a log or a time-diary during at least twenty-four consecutive hours (Pronovost 1989, pp. 76). Through self-observation respondents chronologically report their activities and specify for each new activity the beginning and ending time as well as some contextual information like the place of occurrence and the possible presence of others. The temporal and the behavioural embeddedness of each specific activity makes that the design of the diary is a useful tool for the respondent to report the natural flow of consecutive acts, so that “the time-diary, then, is a microbehavioral technique for collecting self-reports of an individual’s daily behaviour in an open-ended fashion on a activity-to-activity basis” (Robinson 1999, pp. 83). This self-reporting is done either through telephone interview, the so-called *yesterday-method* as applied in the American Time Use Surveys (ATUS) with between 9,000 and 10,000 interviews/diary days per year since 2003, or by completing a paper time diary, the so-called *paper-and-pencil method* as

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applied in the Harmonised European Time Use Surveys (HETUS). In either way, it is this activity-to-activity structure that empowers both the quality and the usefulness of the data. Time-diary methodology largely overcomes the (un)intended biases of survey methodology because respondents reconstruct their daily behaviour by denoting activities that are always embedded in other activities and are restricted to the maximum length of the day, which will benefit the quality. Besides, time-diary methodology serves multiple research topics because it is not a priori focussed on a specific topic of interest (in contrast to, for example, the European Social Survey - ESS).

Nevertheless, besides these benefits time-diary methodology has also its pitfalls. Firstly, it is bookmarked as a technique with a high demand of cooperation resulting in generally low response rates but which do not have necessarily a selective impact on results (Gershuny 2004). Secondly, it is highly expensive because of the wide fieldwork period (mostly the survey takes an entire year), the labour intensive execution, and the time intensive data-preparation (punching and cleaning) in order to start valorising the data. However, a large range of comparative studies show the superiority of time-budget surveys over survey research when it comes to analysing daily human behaviour, especially because the time-diary methodology is capable of taking into account all four parameters of time at once (see for example Michelson 2005).

2 Background of time-use surveys

2.1 The Odyssey of the Harmonised European Time Use Surveys (HETUS)

From the outset of time-use surveys¹ the focus laid on socio-economic issues. The earliest (small scaled) time-use surveys were motivated by the concern that the legal restriction of working hours would result in a working class with much free time to spend but without any ideas what to do (Bevans 1913) and by the occurrence of poverty and child mortality in the poorest families in London (Pember-Reeves 1914). Subsequent (large scaled) surveys kept the same focus, for example, economic and social planning in the communist Soviet-Union (Strumilin 1921-1923) and mapping female agricultural work in America between 1925 and 1931 (Zuzanek 1980; Stinson 1999, pp. 12-14). The international breakthrough of time-use surveys, however, came with the UNESCO-funded ‘Multinational Comparative Time-Budget Research Project’, coordinated by Alexander Szalai (Szalai 1972). Between 1964 and 1966 respondents in twelve countries reported their activities using the same time-diary methodology. The conventions of this methodology are still of crucial importance for today’s time-use surveys (Minnen and Glorieux 2011).

¹ Note that from this point on by ‘time-use survey’ we explicitly mean surveys using the time-diary methodology as briefly outlined in section 1 in combination with questionnaires before and after completing the time-diary.

From that point on, time-use surveys were never to loose their socio-economic angle of incidence and under impulse of the United Nations the application of time-use surveys for quantifying socio-economic development expanded even more during the 80s, for example, by making visible (the timing of) unpaid work (Juster and Stafford 1991, pp. 472; United Nations 2004). This growing use of time-use data preluded two important global developments in the 90s. Firstly, more and more academics started taking up time-diary methodology to analyse a wide variety of social and economical issues and, secondly, more and more national statistical offices started conducting time-use surveys. The former led to the congregation of scholars in the International Association for Time Use Research (IATUR), the latter to a plea for more international comparative data (Harvey 1993) either by *post*-harmonising existing databases or by *pre*-harmonising the time-diary methodology. The *post*-harmonisation has largely been realized by the Oxford Centre for Time Use Research (CTUR) and resulted in an open-access database of Multinational Time Use Survey (MTUS), containing both EU- and American data. The process of *pre*-harmonisation, which logically was not at issue for the American Time Use Surveys but of major importance for the European Time Use Surveys, was not taken lightly and under the leadership of EUROSTAT resulted in a decade of debates and decision making that ultimately culminated in the guidelines on Harmonized European Time-Use Surveys (HETUS) (European Commission 2008). At the same time EUROSTAT promoted time-use surveys in its member states and associated countries, which resulted in comparable datasets of 20 countries.

2.2 The future of the Harmonised European Time Use Surveys (HETUS)

The HETUS-guidelines have resulted in highly comparable and highly valuable international data employed for a wide range of study domains (paid work, unpaid work, gender equality, leisure, ...). Nonetheless, these benefits come at a high cost that directly relate to conducting time-use surveys, including an intensive preparation phase (comprising the different elements like instructions for respondents, questionnaire and the diary, the construction of the sample selection, and the training of interviewers), a yearlong fieldwork period (face-to-face interviews, explanation of the diary procedure, collecting completed diaries), and extensive punching and cleaning of the paper-and-pencil diaries to a digital database. As mentioned, one of the pitfalls of time-use surveys is their relatively low response rate, which means that there often is over-sampling, which increases the costs even more. To give an example, the average cost per respondent of the Flemish 2004 7-day time-use survey was about 265 Euros (about 360 US Dollars). Note that mainly for this reasons the American Bureau of Labor Statistics (BLS) opted for the telephone-aided *yesterday-method* for the American Time Use Survey (ATUS). Although this makes ATUS more cost-efficient, it does have its downside because respondents could only be asked to recall their previous day. Re-assembling a longer period significantly effects the quality of the reports (Juster, Ono and Stafford 2003), because of recall-effects. Nonetheless, the length of the observation window is an important element when studying activities not bounded by the daily cycle (f.e. paid work).

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The combination of high processing costs and on-going cuts in research funding endangers (at least) the EUROSTAT-minded time-use surveys, and this (for the minimum) in two ways. Firstly, it hinders the continuity of conducting time-use surveys and of studying the changes of human behaviour for the wide range of study domains mentioned above. Secondly, and related to the former, it forces researchers to come up with cheaper methods that produce more or less equivalent estimates or to experiment with cheaper alternatives like online time-diaries. The former jeopardizes the comparability, validity and reliability of the socio-economic estimates, though the latter is undoubtedly welcomed because of its low costs. We estimated the marginal costs for a respondent based for an online 7-day time-use survey to be only 60 to 80 Euros and with the continuous growth of Internet access in the European population (Seybert 2011) online time-diary methodology offers a very good prospect. Several countries (Denmark, Belgium, The Netherlands, United Kingdom, Sweden, Australia, ...) have already been experimenting with time-dairy registration through a website (see in Bonke and Fallessen 2010) or a native app (Fernee and Sonck 2013; Sonck and Fernee 2013). Nonetheless, we should not rejoice too quickly, because there is a tremendous downside of all this experimenting: if not done so already, it will put the time-diary methodology right back in the pre-harmonization era!

Assuming that an online time-diary methodology holds the future, the challenge, thus, is to come up with a system that on the one hand can be ultimately agreed on as the new standardized system of time-use surveys and on the other hand produces data that are as comparable as possible to the paper-and-pencil data to continue studying trends. This is the goal we have set ourselves when we received funding for the project called Modular Online Time Use Survey or abbreviated as MOTUS.

In this contribution we outline how we have translated all these features of the paper-and-pencil into a digital time-diary, the insuperabilities we have faced, how we have dealt with them, and the additional features we have included to make this new way of online time-use collecting more practical and easy to use (section 3). Next we provide some preliminary results on the status, quality and response of our pilot study (section 4) and discuss the additional experiments we have planned for the near future, the analyses we will perform to evaluate the online time-diary methodology, and what we expect from MOTUS in the near and distant future (section 5). An English demonstration version of MOTUS can be found at <http://www.motusdemo.com>.

3 Modular Online Time Use Survey

The classical procedure of paper-and-pencil time-use surveys is costly, time-consuming, and involves many personnel for conducting the fieldwork and cleaning and inputting the data. The online procedure of MOTUS has low marginal costs, is less time consuming, and involves many automated systems that replace much of the personnel. This does not, however, mean that the one methodology is a perfect substitute for the other. Reasoning from the latter, there are many elements that the online methodology can do better or more compared to the paper-and-

pencil surveys, but there are also aspects that this new methodology cannot. In this paragraph we will elucidate how we translated all crucial elements of paper-and-pencil time-use surveys into the online methodology of MOTUS, what additional features MOTUS comprises that eases conducting time-use surveys, and what ‘features’ or advantages the paper-and-pencil methodology holds over an online system.

3.1 Translating paper-and-pencil to MOTUS

The standard process of a paper-and-pencil time-diary survey starts with sending out invitation letters (spread over the survey period) to potential respondents (preferably a random sample) notifying them that an interviewer will pass by. This interviewer has the important task of convincing the respondent to participate and, if so, to take the first (*pre-*)questionnaire in a face-to-face manner (using CAPI), explain the procedure of the time-diary, and leave behind a drop-off (*post*)-questionnaire. After the ending date of the time-diary, the same interviewer returns to the respondent and makes a quick check of the time-diary and *post*-questionnaire to adjust possible major flaws in the registration. Hereafter, all paperwork is converted into digital data, often through a double punching procedure, and those responsible for this punching procedure try to undo most of the respondent errors (e.g. unspecified time slots, ambiguous activities, ...) by interpreting the context of activities. This is often seen as a weak link in processing time-use data (see Chenu and Lesnard 2006).

Generally, the mode of paper-and-pencil time-dairies varies along two elements: the registration of time, that is *open-ended* or *fixed intervals*, and the registration of activities, that is *pre-coded* or *verbatim*. In the *open-ended* registration respondents denote the exact beginning and ending time of the activities, whereas in the *fixed interval* registration respondents denote their activities with a 10-minute grain precision. Bluntly stated, the advantage of the *open-ended* mode is a more exact registration compared to the *fixed interval* mode wherein respondents are asked to retain the ‘most important’ activity that occurred in that interval². On the contrary, the advantage of the *fixed interval* mode is that it is less likely to result in unspecified time periods. With regard to the other element, the *pre-coded* mode of denoting activities (i.e., respondents look up the activity in a list of activities and write down the accompanying code) eases the punching procedure and lets the respondents decide how to interpret the activity. However, this might also be seen as a disadvantage, because such an activity list will never be exhaustive and thus might frustrate the respondent when not being able to ‘code’ the activity, hence the existence of a *verbatim* mode.

A final word of importance has to be said concerning the length of observation window. The EUROSTAT-guided (and less burdensome) length is one randomised weekday and one ran-

² Suppose for a certain 10-minute interval that a respondent sleeps 9 minutes and starts breakfast on the 10th minute of this interval. If the respondent decides to register ‘breakfast’ as the most important activity of this 10-minute interval, we would, in essence, mistakenly conclude this respondent to have had breakfast for 10 minutes.

domised weekend day though many scholars prefer a length of seven consecutive days. The *two-day* length builds on the idea that the ‘daily round’ is comparable on all weekdays (and the same for weekend days), whereas the *seven-day* length builds on the idea that a week is made up of seven different ‘daily rounds’ (Weigert 1981; Zerubavel 1985).

The procedure of the 2013 Modular Online Time Use Survey (MOTUS) also starts with sending out invitation letters³ (spread over the survey year) but now include a username and password with which respondents are invited to register themselves on the website. Once logged on, they are invited to change their password and voluntarily provide an e-mail address and/or a cell phone number in order to contact them. Hereafter they are invited to start the online pre-questionnaire that contains all features as any other online survey (different types of questions, routing based on previous answers, ...). After completion of the *pre*-questionnaire the respondents are guided through a communication page that tells them when to start logging their time-diary and provides several explanatory links (instruction page, instruction video, activity list, note page for mnemonic, ...). When finished the time-dairy for the given period, a new communication page asks the respondent to fill in the *post*-questionnaire to finally complete the survey. Hereafter a final communication page passes on the respondents ‘lottery number’ to win a money price and a web link that gives them an overview of their own time-use in comparison to the population sample results, which both are the incentives of the 2013 online time-use survey.

With regard to time registration we have taken a middle course: the default time slot that is suggested on the diary page is set at 10 minutes, albeit respondents are free to adjust the beginning time and ending time to the very precise minute. Concerning the activity registration we offer respondents two pre-coded ways of registering an activity. The first is a *selection* method that let respondents stepwise choose from a 3-level tree structure their main category, the sub-category, and finally their detailed activity. The second is a *search* method that let respondents to type in a keyword (including the activity code) that generates a list to which this term is tagged and from which the most detailed activity can be selected. These activities are also sorted based on their occurrence in the registration procedure⁴. Additionally, at the level of the sub-categories we provided an ‘empty’ category allowing respondents to write down their activity verbally if none of the pre-coded activities sufficed. Finally, the length of the time-dairy is set at 7 consecutive days.

3.2 Benefits of MOTUS over paper-and-pencil

Methodologically, most of the benefits of MOTUS relate to controlling the quality of the time-diary registration. Firstly, to reduce the unspecified time, the ending time of the previous activi-

³ Respondents of the pilot project of MOTUS were randomly drawn from the population register. The sample contained information on the names and the contact addresses of the respondents (street, number, postal code and city/municipality).

⁴ For example, if a respondent types in ‘baby’ the first activity suggested list is ‘taking care of baby: washing, bringing to bed, soothing’ and the last activity suggested is ‘taking baby to general practitioner’.

ty is suggested as the beginning time of the next activity. If respondents do leave open a period of time, this time slot will appear in red in the respondents' timeline overview and allows the respondent with one single click to still edit this time slot.

Secondly, like any online registration method, several algorithms can be run to perform real-time verifications. We distinguish *hard warnings* from *soft warnings*. While the former cannot be ignored the latter can. Examples of *hard warnings* include the impossibility to register activities in the future and the impossibility to leave certain fields open (f.e. whether one was alone or someone else was present during the registered activity). Examples of *soft warnings* include a notification if an activity endures longer than 20 hours (which is often the result of wrong date setting) or a notification of not having registered a displacement if the location of two sequential activities has changed. Besides those warnings, the system also communicates encouragements, for example, by complimenting respondents for every day they completed and by counting down the days to be filled in.

Administratively, MOTUS has some major beneficial features like Direct Data Storage (DDS), Respondent Management System (RMS), Respondent Tracking System (RTS), and Customized Survey System (CSS). The DDS facilitates the storage of all respondents' input to a direct available database, which makes the (time- and cost expensive) procedure of (double) punching unnecessary. The RMS on the one hand automates the mail handling, for example, with respect to randomly assigning respondents to different research modules (see section 3.4) and equally (and randomly) spreading respondents over the survey period, and on the other hand randomly assigns starting days for the time-diary⁵. The RTS allows sending out notifications or reminders via e-mail or text messages if respondents pass pre-defined 'states' of the survey. Such states might be 'not having registered any activity for the past 24 hours', or 'having completed the time-diary but not the *post-questionnaire*'. Additionally, the RTS stores the respondents' *para data* like logging times, browser type, time lapse of completing certain aspects of the time-use survey, and so on. The RTS thus allows real-time monitoring of respondents and intervention (through notifications) when needed and in a sense largely replaces the interviewer. Finally, the CSS allows creating several surveys at the same time or altering existing surveys period by deciding on all elements mentioned above: whether or not to include *pre-* or *post-questionnaire*, *open-ended* or *fixed interval* mode, *pre-coded* or *verbatim* mode, number of (levels of) activities, number of days, and so on. This adds a high degree of flexibility to (time-use) surveys compared to the paper-and-pencil method for which every alteration means reprinting and re-distributing questionnaires and time-diaries.

⁵ In case of a seven-day registration length, the RMS randomly assigns the starting day and in case of a two-day length the RMS randomly assigns a starting weekday and, when completed, a starting weekend day (or vice versa) with a maximum of a 6-day difference (Monday-Sunday or Saturday-Friday).

3.3 Benefits of paper-and-pencil over MOTUS

Like any online survey one element is untranslatable and that is the human factor involved. When it comes to persuading people to participate in surveys, especially in the somewhat more burdensome time-use surveys, personal contact cannot be underestimated. Someone explaining the need/aim of the survey, guaranteeing anonymity, and immediately answering the most pressing questions might instil more confidence than a letter with an encrypted username and password. Especially in times where eavesdropping, NSA, and PRISM are daily news. Here the telephoned-aided American Time Use Surveys has an advantage over online time-use surveys because there is still human contact between interviewer and interviewee. We did try to overcome this feature by placing a special made short video on the importance of time-use surveys on the MOTUS homepage, by having a special phone number that invitees to the survey can call, by trying to respond to e-mails within one day, and by putting a privacy statement on the website. Though this will never replace face-to-face contact with an interviewer.

3.4 Modularity

The ‘M’ of MOTUS stands for modularity and part of this modularity has already been explained in the previous subsections: all elements of the survey itself and the administrative features are adjustable to one’s wishes. There is, however, a modularity that has been underexposed so far and that has to do with registering the context of activities. In all time-diaries respondents are asked to provide the context in which the activity took place, that is, respondents denote who else was present, with whom they talked, where the activity took place, and (in some cases) what motivated them to perform that activity (Glorieux 1990). From the perspective of different research domains, different contextual information might be of interest, though this idea has never been taken up by any time-use survey for several reasons. Firstly, paper diary layout simply lacks space to include more contextual information. Secondly, assigning different contextual questions to different parts of the survey requires a lot of administrative planning and coordination. Thirdly, most of this type of contextual information is activity-specific and thus need not to be completed for every activity.

An online time-use survey methodology might easily overcome these problems and that is what we have tried in the pilot study. We developed three ‘modules’ that should test questioning additional context information. The first module, the *base* module, only questions the ‘typical’ context information (what activity was done, where it took place or what transport mode was used, and with whom the activity was undertaken). The second module, the *media* module, questions for every activity whether any media (smartphone, tablet, laptop, written media, ...) has been used. The idea behind this module comes from the fact that the use of, for example, smartphones or tablets are so well established in daily life that their usage is hardly ever registered as an activity. This module is developed in consultation with the research group on Studies on Media, Information and Telecommunication (SMIT) of the Vrije Universiteit Brussel.

The third module, the *transport* module, questions contextual information only if the respondent registers a displacement and is developed in consultation with the research group on Business Technologies and Operation (BUTO) of the Vrije Universiteit Brussel who focusses amongst other things on logistics. This module demonstrates the feasibility to link a particular questionnaire to a particular activity. That is, if and only if respondents registers a displacement, the system generates a small questionnaire asking, for example, the mode of transport or scaling the ease of transport. It is obvious that running activity-specific questions is not an option in paper-and-pencil diaries; you either print all possible contextual questions or ask none. Additionally, both modules allowed testing if there is some sort of upper limit of the number of contextual questions that a respondent will answer. We did not, however, find any negative effects of these additional questions. Respondents in the transport module did not register less transportation activities compared to the base module in order to avoid these questions.

Both modules generate context questions based on answers that were given in the pre-questionnaire (what multimedia devices do you own?, how many cars do you own?, what type of car(s) do you have?, ...). The ease of modulating questions gathering this activity specific contextual information truly does justice to the ‘M’ of MOTUS.

4 Preliminary results

It is important to know that the Research Group TOR (TOR being the acronym of Tempus Omnia Revelat which translates to Time Reveals Everything) of the Vrije Universiteit Brussel has developed the methodology MOTUS and that TOR has an extensive expertise in conducting and analysing time-use surveys. It has conducted a small sample time-use survey in 1984, a time-use survey with emphasis on additional contextual information in 1988, two Flemish population time-use surveys in 1999 and 2004, and had an advisory role in the Belgian population time-use surveys in 1999, 2005, and 2013. All this expertise has been of crucial importance in determining the strategy of the development of MOTUS, which we will call a top-down approach: we aimed for MOTUS to be capable of conducting the most extensive, though reasonable, time-use survey we could think of. This implied having an elaborate *pre*-questionnaire, a 7-day time-diary with *open-ended* time registration and a list of over 225 activities, an elaborate *post*-questionnaire, and the implementation of three different research modules with respect to contextual information. Moreover, we decided the pilot study to be a population study, for at least two important reasons: firstly, to get an insight in the (selective) non-response and secondly, because we planned the survey period of MOTUS to run parallel with the survey period of the paper-and-pencil population time-use survey of 2013 as conducted by the National Institute of Statistics Belgium (NIS) following the HETUS-guidelines. The latter allows us to compare both methodologies and if needed to benchmark MOTUS with these paper-and-pencil-data and to see if we need to weight the online data in case online effects come forward. Nonetheless, the choices for a top-down approach and a pilot population study off course have an important

impact on measuring participation. In the following section we provide some preliminary insights on the participation of our surveys and the quality of our data.

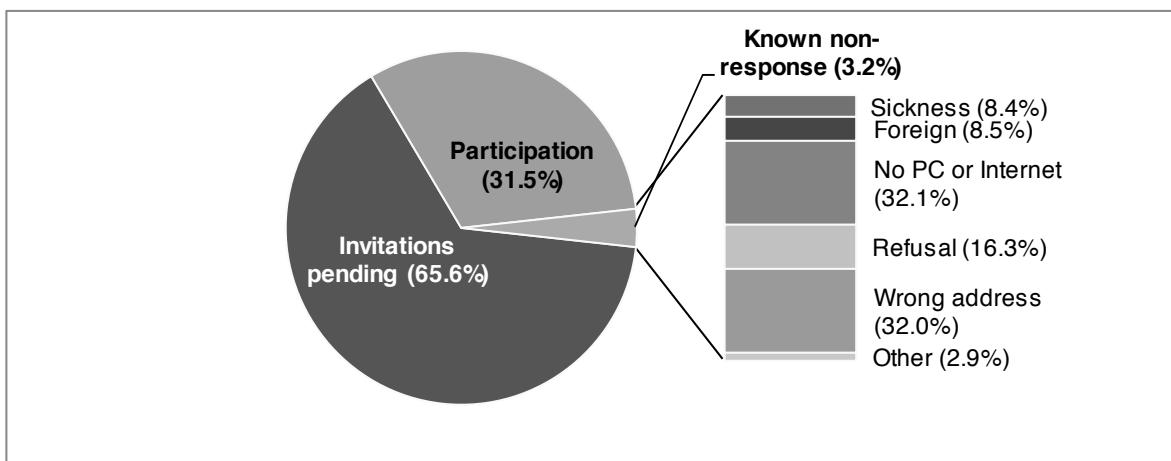
4.1 Participation

One of the main measures of participation used in any survey is the *response rate*. Nonetheless (and especially in time-use surveys), there (still) does not exist a clear consensus on how to define a response rate, even though Kviz started this discussion already in 1977 and the American Association for Public Opinion Research (2011) provides (and updates) standard definitions since 1998. For example, whether to calculate it using the raw sample size, or whether to first adjust the sample size for certain noise like nonexistent addresses, deceased respondents, illiterate respondents, households with no Internet access, or even whether to count respondents that delivered unusable data because they simply do not fill in all days, not in a consecutive order, or do not meet certain standards (e.g. by registering only 2 activities per day). This implies that such measures are almost always incomparable and this is often worsened by not clearly specifying the conditions of the survey design, for example, whether the sample is drawn from an ‘experienced’ panel, whether the survey is linked to another survey, or whether the sample is randomly selected from the population register. In order to evaluate MOTUS in terms of (non-)participation, we, therefore, split up the whole procedure as outlined in the previous section in *stages*. Note that we do not distinguish between the different modules of MOTUS because, even though significant ($\chi^2=25.916$, $p=0.004$), pairwise comparisons show that this is only the result of a slightly higher percentage of respondents in the media module finishing the *pre-questionnaire* and a slightly lower percentage of respondents in the media module finishing the whole survey. All other differences in percentage of stages over these modules are negligible.

All figures concern the 39,756 persons between 18 and 75 years old that have received an invitation letter and at most two reminders in the period January 2013 until half of March 2014 and the progress of this time-use survey is downloaded from the MOTUS server at 14 April 2014. Of all invitations, over 65% are still pending (see Figure 1), though this percentage definitely will include a large part of the non-response, if only because in Flanders almost a quarter to thirty per cent of the households still has no PC and/or internet connection at least not for 7 consecutive days and even 15% of the Belgian have said never to have used Internet before (Belga News Agency 2013; Statistics Belgium 2014). The latter is nicely reflected in the almost 3.2% of persons of which we are happy to know their non-response. Almost one third of the known non-response relates to this problem and another third relates to wrong or non-existent addresses. The other non-response relates to refusal of participation, sickness, non-natives, and a small miscellaneous category that includes amongst other things illiterate or deceased persons. In relation to the absence of a home computer or Internet connection the paper-and-pencil design has an advantage over online surveys. Additionally, having interviewers that can ask about the refusal to participate or can give their appreciation about the reason of non-

participation (e.g. address not found, respondent has moved out, ...) will off course make the non response more transparent.

Figure 1
Participation and known non-response



Source: MOTUS 2013, Own illustration.

Almost a third of the invitations are answered and once logged to the system we make two important observations in relation to the participants. The first observation is rather ambiguous: over 90% of the respondents complete the *pre-questionnaire*, over 80% takes a preview of the time-diary, but only 52% of the respondents start using the time-diary (i.e. log at least 1 activity). At this point we thus somehow face a dropout of almost half of the respondents that logged on to our system. Probably, one main reason for this dropout is that although every respondent has immediately access to their time-diary, the randomly assigned starting day not necessarily follows the day on which they complete the *pre-questionnaire*. The reason for this is that in following the HETUS guidelines of EUROSTAT, we let the system randomly assign starting days to keep track of the quota of dispersion of starting days over the week. Other reasons might be respondent fatigue or (technical) difficulties with logging activities. From respondents that contacted us on the telephone helpline and from the *para data* on the used Internet browsers during the study we learned that some used old computers with slow processors that badly performed when loading the time-diary pages and from the logging data that are stored automatically to the server, we learned that several respondents had out-dated Internet browsers that were unable to visualise the online diary properly⁶.

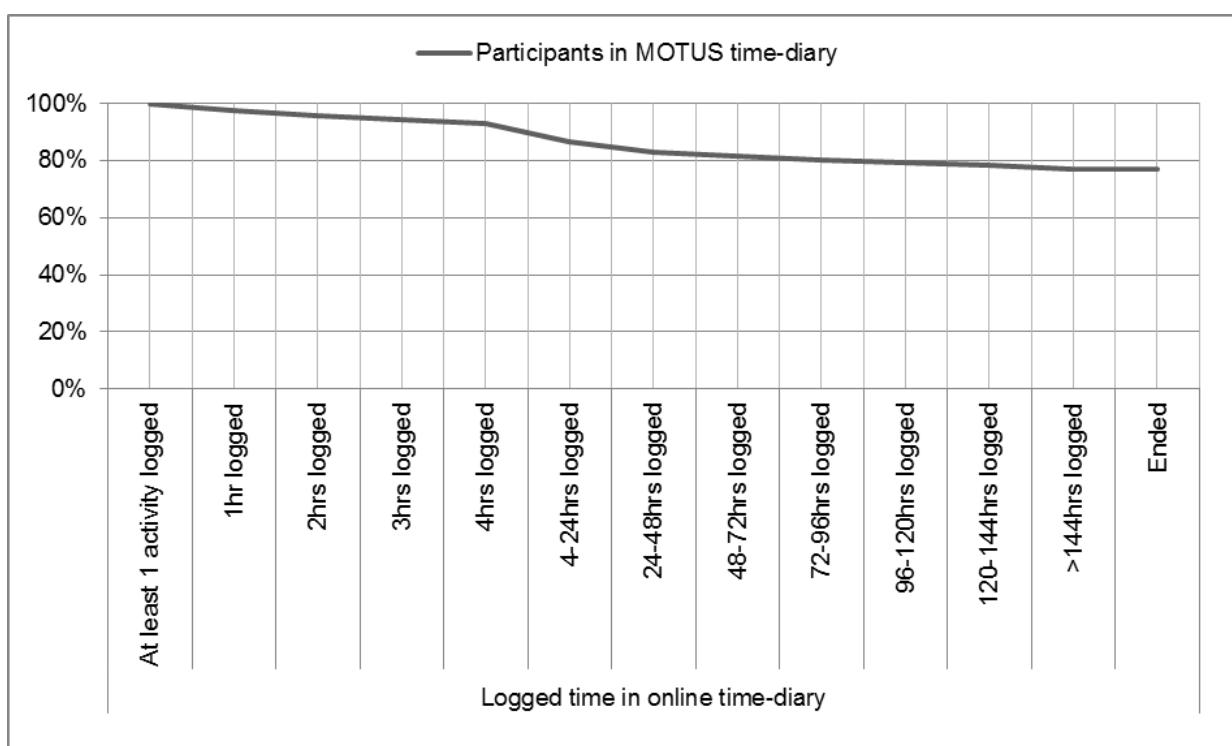
Paper-and-pencil time-use surveys are known for their low response because of the intensive survey procedure. Apparently, the online version does not immediately alter this, although obviously we did not expect this from the first population pilot study in which we tested the most

⁶ Especially Internet Explorer 6 and lower caused some troubles with the visualization of the time diary.

demanding fieldwork setup that lasted in total at least 10 consecutive days⁷. However, online time-use surveys like MOTUS do have the advantage of knowing more about the drop-out non-response compared to paper-and-pencil time-use surveys, simply because all data are immediately stored on the server. For any respondent starting the survey and dropping out the answers given already are kept in the database. This allows answering questions like ‘at what question did respondents quit?’ or ‘what are the characteristics of respondents not continuing with their time-diary?’.

The second observation, though, is certainly positive: once respondents logged their activities in the time-diary for up to 24 hours, they are very likely to complete the whole survey which underlines the easy and intuitive registration flow of the MOTUS time diary design (see Figure 2).

Figure 2
Participants by logged time in online MOTUS time-diary



Source: MOTUS 2013, Own illustration.

In other words, the crucial point of MOTUS apart from persuading more people to accept the invitation thus is to convince people to continue to the start phase of the time-diary and start experimenting with the log-procedure, because once familiar, it turns out not too difficult to

⁷ After the respondents completed the pre-questionnaire (day 1) the starting date of the diary registration was communicated. This diary could start the earliest the following day (day 2) and existed of a learning period from 19h till 24h. At midnight (day 3) the actual period of 7 days started and lasted until all days were completed (day 9) and the ending time of the last activity ran over midnight (day 10). After the diary registration was ended respondents also had to fill in a short post-questionnaire.

complete the time-diary. Note that this applies to people that have the possibility to participate in an online survey. If we want to include more people in a time-use survey in general, we might, for example, opt for a mixed mode (online and paper-and-pencil). To further elaborate on the above results we can have a look at Table 1.

Table 1
Response by population characteristics (in %)

	Population sample	Respondents	Respondents starting time-diary	Respondents completed at least one diary day	Respondents completing MOTUS
Gender					
Male	50.1	52.8	48.8	44.1	43.9
Female	49.9	47.2	51.2	55.9	56.1
Age group					
18-24 years	10.9	13.2	13.9	13.7	13.3
25-39 years	25.2	26.1	26.7	26.2	24.7
40-54 years	30.2	31.3	30.3	31.6	32.0
55-64 years	18.3	18.8	18.1	19.5	20.1
65-75 years	15.3	10.7	11.0	9.0	9.8
Level of education^a					
Low	29.5	22.3	25.5	15.3	14.7
Medium	39.3	35.7	36.9	34.6	34.0
High	31.2	42.0	37.5	50.1	51.3

a: Distribution of level of education in weighted population sample based on Belgian Labour Force Survey 2012 (Flanders only), Source: National Register 2012 (population sample gender and age), Belgian Labour Force Survey 2012 (population sample education), MOTUS 2013 (respondents), own calculations.

Based on the presented results we might conclude that we were somewhat too overanxious with respect to the selectivity of our response. As it turns out females are only slightly overrepresented in our response compared to the population sample and the oldest age group (65-75) are some mere percentage points underrepresented. For the level of education of our population sample we use the information of the Flemish subsample of the Belgian Labour Force Survey (LFS) conducted by the Belgian National Institute of Statistics. The LFS sample can be regarded as being representative for our studied population in 2013 and based on the results we might carefully conclude that the lower and medium educated are slightly underrepresented in our response and the higher educated somewhat overrepresented⁸. Even more striking is the finding that the distribution of these characteristics hardly changes after the dropout during the transition from *pre-questionnaire* to time-diary. Again this lets us provisionally conclude that our

⁸ Levels of education: low=at most lower secondary education, medium=at most higher secondary education, and high=higher education or university degree.

concern about participation rates should not be with selective response, but with convincing respondents to make the step from finishing the *pre*-questionnaire to starting the time-diary.

Nonetheless, we do have to conclude from the last column of Table 1 that over the whole process of completing MOTUS, we do lose males, those 65 and over, and lower educated respondents.

4.2 Quality of time-diary data

From the previous subsection we derive that the time-diary is the most burdensome element of MOTUS to complete. Nonetheless, once started, respondents do go through the whole process of completing 7 consecutive days. A next question to address concerns the quality of the completed time-diaries. We can judge this quality by three indicators (Juster 1986): (1) the average number of activities registered per day, (2) the average number of minutes of unspecified time per day, and (3) the percentage of activities rounded to obvious time slots (e.g. to 1 hour or to 10 minutes). Table 2 gives an overview of these three indicators per registration day. We also contribute to the debate whether or not the registration quality declines as the number of diary days increases. Note that these days do not concur with the days of the week, since each respondent is randomly assigned a starting day. Further note that we again do not distinguish between the three different modules of MOTUS since none of scores on the indicators significantly differs between these modules⁹. This finding is an indication that counters the idea of ‘negative respondent learning’ resulting in respondents that avoid registering activities that generate extra questions (and thus require more time). For the former two indicators Table 2 also provides the figures by gender, age group, and level of education.

Firstly, the average number of activities registered per day is 18 and varies between 17.1 on day 1 and 18.3 on day 7. Although this figure is slightly lower than the median of 21 (primary) activities achieved by HETUS-based paper-and-pencil time-use surveys (Rydenstam and Wadeskog 1998), the difference is negligible when comparing to the average number of 18 registered activities per day in previous 7-day paper-and-pencil time diaries of the Flemish 1999 and 2004 time use surveys using an open time registration and pre-coded activity list . Apart from the average per day, it is more interesting to mention that regardless of the population characteristics, figures hardly vary over the day and variance is small, which all points in the direction of a ‘learning curve’: respondents provide more detail once familiar with the registration system (which is contrary to general belief). Note that difference between sexes, age groups, and levels of education do not say anything about the quality of the data. It is known that women, 25 to 54-year-olds, and the higher educated have a more fragmented time-use and thus register more activities (see for example Glorieux, Laurijssen, Minnen and Van Tienoven 2011).

⁹ Combined difference between modules for average number of activities per day: $F=0.554$, $p=0.574$. Combined difference between modules for average number of minutes of unspecified time per day: $F=0.118$, $p=0.889$.

Table 2
Overview of three indicators of quality of time-diary data

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Overall
Number of registered activities								
General mean	17.1	17.3	17.5	17.5	17.7	17.9	18.3	17.6
Differences between days: $F=5.586$, $p<0.001$, $\eta^2=0.002$								
By gender								
Male	15.6	15.7	16.2	16.1	16.3	16.6	16.9	16.2
Female	18.3	18.6	18.6	18.7	18.9	18.9	19.4	18.8
Differences between sexes: $F=410.406$, $p<0.001$, $\eta^2=0.019$								
By age group								
18-24y	15.9	16.4	16.2	16.1	16.4	16.4	16.9	16.3
25-39y	17.6	17.6	18.1	17.8	17.9	18.4	18.8	18.0
40-54y	17.6	18.0	18.2	18.3	18.4	18.4	18.5	18.2
55-64y	16.7	16.8	16.9	17.2	17.7	17.8	18.7	17.4
65-75y	16.6	16.3	16.7	16.8	16.7	17.0	17.6	16.8
Differences between age groups: $F=27.401$, $p<0.001$, $\eta^2=0.005$								
By level of education								
Low	14.9	15.1	15.3	15.4	15.5	15.9	16.3	15.5
Medium	16.6	16.8	16.9	16.7	17.0	17.0	17.5	16.9
High	18.1	18.3	18.6	18.7	18.9	19.1	19.5	18.8
Differences between levels of education: $F=173.158$, $p<0.001$, $\eta^2=0.017$								
Minutes of unspecified time								
General mean	19	2	1	1	0	0	2	3
Differences between days: $F=88.646$, $p<0.001$, $\eta^2=0.025$								
By gender								
Male	19	3	0	1	0	0	2	3
Female	18	2	1	1	0	0	2	3
Differences between sexes: $F=0.012$, $p=0.913$, $\eta^2<0.001$								
By age group								
18-24y	12	1	2	1	0	0	1	2
25-39y	8	1	1	0	0	0	3	2
40-54y	20	2	1	1	0	0	1	3
55-64y	27	4	0	1	0	0	1	5
65-75y	44	7	1	1	0	0	2	8
By level of education								
Low	21	3	1	2	0	0	1	4
Medium	22	3	1	2	0	0	1	4
High	15	2	1	0	0	0	2	3
Differences between levels of education: $F=3.547$, $p=0.029$, $\eta^2<0.001$								

Table 2 (Cont.)

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Overall
Rounded to	Percentage of activities by rounded time slots							
1hr.	11.3	10.1	9.3	9.2	8.9	8.5	8.6	9.4
½ hr.	16.4	15.4	14.9	14.4	14.0	14.1	13.7	14.7
20 min.	13.9	14.2	14.7	14.9	14.8	15.3	15.3	14.7
10 min.	23.1	24.3	24.8	25.1	25.3	24.7	25.1	24.6
5 min.	33.0	33.8	34.0	34.2	34.7	35.0	35.0	34.2
< 5min.	2.4	2.2	2.3	2.3	2.3	2.3	2.4	2.3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Percentage distribution differs between days: $\chi^2=586.738$, $p<0.001$, $\eta^2=0.002$

Source: MOTUS 2013 (respondents), own calculations.

Secondly, the average number of minutes of unspecified time also underlines this short learning curve. The first day contains an average of 19 minutes of unspecified time (on a total of 3,600 minutes per day), but this figure immediately drops to only 3 minutes on day two and gets negligible on the days thereafter. Again we conclude that once respondents start the time-diary and complete one day, there is no additional hurdle in completing the whole time-use survey. This holds for everyone, even for the oldest age groups and lowest levels of education. They only seem to have some more troubles with completing the first day but not with days thereafter.

Thirdly, the percentage of activities rounded to obvious time durations give an indication of whether respondents take the easy way out of the time-diary or not. Again these figures are optimistic. Over half of the activities are registered with duration of 10 to 5-minute time slots and this remains relatively stable over the days. Besides that, the percentage of activities rounded to 1 hour or half an hour slightly decreases over the days again indicating that respondents quickly adopt the entry procedure of the time-diary and register their activities in more detail.

5 Discussion

As we outlined above, the top-down approach of our pilot-study was rather ambitious. Conducting a large-scale population (18 to 75 years old) study without any help of an interviewer on a full time-use survey design that lasts at least 10 days since it includes extensive *pre-* and *post*-questionnaires, a 1-day time diary learning day, a 7-day time diary registration, and different modules to test the modularity of the contextual questions in the time-diary. With regard to the latter, we conclude that the different modules (read: different and additional contextual questions) do not result in different tendencies with regard to the participation in MOTUS. Apart from that, the pilot-study revealed some bottlenecks in the time-use survey design that require further investigation, modification, and evaluation. In this final section we briefly discuss current and future experiments that should increase the participation rate and even (more)

higher the quality of registration (*en surplus*), we outline how we will continue to evaluate MOTUS, and we elucidate on what we expect from MOTUS in the future.

5.1 Small-scale experiments

The absence of an interviewer is an often-named flaw of the digitalization of surveys and although the confidence building contact with a real and reliable person might convince more people to take part in social surveys (especially in times with the NSA and PRISM as on-going headline news), we rather see its absence as merely insurmountable. Therefore, we aim at making meaningful adjustments in the survey design and methodology to see whether they positively affect people's willingness to participate and perseverance to continue. Note that this adjustability is one of the main advantages of online social surveys since it does not require any reprinting and redistribution of questionnaires and/or time-diaries.

Currently we set up an experiment that changes three elements of MOTUS in order to benefit the participation and continuation rates. Firstly, we invited 1,000 people to complete their time-diaries only for one randomized weekday and one randomized weekend day instead of 7 consecutive days (which is basically what EUROSTAT-HETUS prescribes). Secondly, we invited another 1,000 people that are proposed a fixed incentive of 10 euros for completing MOTUS. Currently, people are awarded a lottery number that will give them a 1 out of 4 chance of winning a money-price (ranging from several prices of 10 euros to one price of 500 euros). Thirdly, for another 1,000 invitees we change the three-level structure of activities (see section 3.1) to a two-level structure, which reduces the number of activities from which to select from 225 to 49 activities. Based on the results of this round we will make combinations of these adjustments and test these again, but we already see that reducing the registration days from 7 to 2 (one weekday and one weekend day) significantly higher the number of respondents starting and finishing the diary registration. This also shows that the automated communication to assign respondents to different days and remind them to start the second day (which is not necessarily the next day since, like in the HETUS-format, we question a weekday and a weekend day) works properly. Also the two other tests have a merit towards the original setup.

Another experiment that is on the drawing table is conduct MOTUS in a *mixed mode* setting, that is, letting people choose whether they want to participate via the online modus or via the classic paper-and-pencil modus, or to (re)introduce the interviewer to convince respondents to participate and instruct people how to use the online diary registration. Both suggestions, undoubtedly, will increase the costs of conducting time-use surveys but this will still be less than a traditional paper-and-pencil design. Additionally, this gives the opportunity to include the 25 to 30% of households that do not have access to a PC with Internet connection.

Furthermore, we are redesigning the visible front-end of the time-diary. At this moment we use a sequence of input fields and display all entries in a time-line on the right-hand of the screen (Twitter view). However, we are interested in knowing whether an agenda-layout with the possibility to cut, copy, paste and drag activities might generate different results, since many peo-

ple are already familiar with such designs (f.e. like Google calendar), or if a Life History view would be beneficial, which make it possible to develop an e-Work Grid as one of the research tools of HETUS. Additionally, we are trying to have the activity registration resemble the HETUS way of registering by allowing respondents to type in what they have done and use artificial intelligence to have the MOTUS-software analyse the inputted description and show to the respondent a number of related pre-coded activities. If the respondent chooses one of this suggestions the verbatim activity is already coded at no extra costs at a later stage.

Finally, we are currently working on developing an application for smartphone/tablets for all main operating systems (e.g. Android, iOS and Windows) that complements the online time-diary registration. This allows people to complete their time-diary entirely on a smartphone/tablet, or to make brief entries in their time-diary using the App, synchronise it on their computer via the website of MOTUS, or the other way around. Of particular importance is that respondents carry the smartphone/tablet with them almost all the time as if it were the ‘paper-and-pencil booklet’. Pilot panel studies in the Netherlands have shown that people tend to use their smartphone to log an activity about 11 to 12 times per day. This is obviously more than can be expected from an online diary via a desktop or laptop.

5.2 Using the MOTUS database

As far as we know, MOTUS is the first online time-use survey ever conducted on a population scale so there exists no evidence on the reliability of time-use estimates gathered through online time-use surveys. Therefore, we have deliberately chosen to conduct MOTUS parallel with the third wave of the 2-day Belgian time-use survey following the HETUS-guidelines (raw response rate of 19%). The latter, with a sample drawn from the same population, still uses the classical paper-and-pencil methodology, which enables us to analyse the reliability of the time-use estimates of MOTUS and compare both methodologies. Additionally, since we know that the response is selectively biased, this allows us to calibrate the MOTUS database with both the population and the Belgian time-use survey before using it for profound time-use analyses.

Furthermore, the MOTUS database contains a lot of data that are often referred to as *para data*. These data include type of browser used, times, dates and duration of respondents’ logins, times, dates, and time-lapse of completing different fields of the questionnaires and time diary, loading times of submitting activities or retrieving questionnaires, and so on. Analysing these kinds of data will tell us a lot about the actual completion-behaviour of respondents, a view in term of quality measures that has never attempted by the traditional paper-and-pencil method.

Additionally, the ‘stacked’ design of MOTUS (*pre-questionnaire, time-diary, post-questionnaire*) in combination with the direct storage of any data inputted in the system, provides us with little up to a lot of information (based on their progress in the time-use survey) of the ‘drop-out-response’. Compared to partially completed paper-and-pencil questionnaires or diaries that end up in the trash, we might use these interrupted data to touch upon the some of the sore points of our time-use methodology.

5.3 The future of MOTUS

We are aware of the fact that MOTUS as a methodology for conducting online time-use surveys still has some important steps to take. Nonetheless the ambitious top-down approach for the development of MOTUS has one major advantage: almost every element of time diary research that one might think of is included in the software ready to be adjusted. Additionally, the MOTUS-software is future-proof in a sense that it allowed for optional plug-ins that might facilitate time-use registration (e.g. data gathered by GPS' or accelerometers on smartphones). Within MOTUS there is still a lot to explore, design, and test and through this flexibility and modularity we hope to avert the scenario of ending up with multiple, freestanding, non-harmonized online time diary software. Therefore, we aim at setting up a broad international network of statisticians of National Bureaus of Statistics and international university research departments to jointly develop and fine-tune the future of online time-use research to arrive at a standard for conducting online time-use surveys; a sort of HETUS 2.0. The time-use community came a long way to harmonize the paper-and-pencil time-use methodology and make cross-national comparisons possible, especially in Europe, and we cannot imagine anyone willing to abandon this harmonisation. Nonetheless, the quest for cheaper time-use methodology does endanger this achievement. We already anticipated this by thoroughly designing the basics for an online time-use methodology but maintaining European or internationally harmonised guidelines cannot be done by us alone.

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