¡Sub! localisation workflows (th)at work

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Over the last few years, cloud-based environments have simplified traditional localisation workflows and have made it possible for virtual teams of audiovisual translation (AVT) professionals to work together from all corners of the earth (Díaz Cintas and Massidda 2019). In addition, AI-powered technologies have been integrated into localisation workflows to accelerate translation processes: this has led to a progressive automation of AVT practices and has created brand new roles for language professionals. This paper presents the preliminary results of the international pilot project *¡Sub! Localisation Workflows (th)at Work* (2020–2022). A series of experiments was conducted in the spring of 2021 to compare three different workflows in the subtitling of documentaries: traditional (i.e., using only subtitling software), semi-automated (using automatic speech recognition and captioning) and fully automated (relying on automatic speech recognition, captioning and machine translation). The experiments involved twenty-four final-year MA students and recent graduates from UNINT and Roehampton University (twelve of them working from English into Italian and twelve from Spanish into Italian), in subtitling teams that included a project manager, a spotter, a subtitler, and a reviser. All the work was recorded via screencast technology and documented in a project logbook, a quality assessment form, and a workflow summary sheet. The aim of the experiments was to identify the most effective workflow equation, i.e., the one able to deliver the best quality output in the tightest turnaround time. This paper illustrates the experimental set-up and materials and discusses the preliminary results emerging from a quantitative and qualitative analysis of our data.

Keywords: audiovisual translation, subtitling, automatic speech recognition, machine translation

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1. Introduction

AI powered technologies have become virtually omnipresent nowadays (Díaz Cintas and Massidda 2019). These powerful tools have slowly triggered a chain of transformation processes that humankind is still attempting to decipher and regulate. This radical revolution, in turn, has affected humankind itself, having profoundly altered the way we work, study, retrieve and process information, express ourselves, interact and communicate with each other, amongst other things (Schwab 2016).

State-of-the-art technologies for translators working in the media localisation industry are currently under scrutiny, part and parcel of on-going debates on human-machine interaction, human agency, and the ethics of technology in conferences, symposiums and publications addressing the shortage of translators and the crisis of the subtitling profession within the scientific community.

Since the beginning of the new millennium, cloud-based subtitling platforms, increasingly introduced into audiovisual translation (AVT) workflows by Language Service Providers (LSPs) with the aim of managing multiple projects and speeding up processes, have drastically decreased costs and increased overall productivity. These major changes, leading to a rapid evolution of cloud-based applications, have caused profound transformations in the AVT industry.

As Moorkens (2020, 15) points out, "Taylorism", a work system proposed by Frederick Winslow Taylor in 1911 and focused on closely monitored workflows arranged in such a way so as to increase overall productivity, has experienced a revival in recent years, the so-called 'Digital Taylorism' (Parenti 2001, online). According to this approach, tech companies and LSPs have prioritised efficiency and objectivity to the point that "outputs must be quantified, and workers continually audited" (Parenti 2001, online). In addition, the majority of professionals in the translation and media localisation sector work on a freelance basis with contracts that are essentially averse to professional empowerment and agency (Moorkens 2017).

The high value of translation as a professional activity (Do Carmo 2020) is a matter that requires further scrutiny, especially in the context of human-machine interaction and the ethics of audiovisual translation technology. Furthermore, the effect that the streaming industry model has had on professional localisation workflows, with its ever-increasing demand for AVT services, which is forcing LSPs to contend with the reduction of budgets and the time pressures it has imposed (Díaz Cintas and Massidda 2019), is still largely under researched. Thus, the present study was conceived to single out those factors playing a crucial role in technologically driven localisation processes: the degree of automation, time,

the quality, and value of the translation output and, last but not least, the human touch.

2. State-of-the-art of the entertainment and media industries

> We recognize the shifts that made this possible as caused by "the internet," "tech," or "digital" [as] they enabled the creation of global companies such as Netflix.
> (Lotz 2021, 7)

At the start of the new millennium, the technical and commercial development of 'Web 2.0', a concept first introduced by DiNucci (1999), utterly transformed the world as we knew it by promoting a progressive democratisation of media production on a global scale. The first Web 2.0 conference was held in 2004 and organised by Tim O'Reilly (2005) who popularised the new 'interactive web' widely. Related expressions coined thereafter include 'ubiquitous computing' (Cronin 2010), 'web-as-participation-platforms' (Decrem 2006), 'prosumers' (Toffler 1980; Bruns 2008a; Ritzer, Dean, and Jurgenson 2012) and 'produsage' (Bruns 2008b). Formerly intended to define the brand-new scenario created by Web 2.0, whereby consumers started intervening in the creation process, this portmanteau of 'producer' and 'consumer' (Massidda 2015) has come to define the real protagonists of the digital revolution, participating in the transformation of goods and services offered by digital multimedia systems.

Against this backdrop, AI-powered technologies brought about by Web 2.0 have slowly modified traditional professional translation processes, challenging the notion of high quality "as consumers preferences seem to have shifted towards immediacy, greater interactivity, and lower costs" (Díaz Cintas and Massidda 2019, 265). Since then, LSPs have attempted to optimise their internal workflow by trialling and testing various degrees of automation, introducing AI-powered technologies such as Neural Machine Translation (NMT), Automatic Speech Recognition (ASR), and Translation Memories (MTs), whilst at the same time outsourcing subtitling projects and promoting a swift shift to decentralised, cloud-based localisation workflows.

Over the last few years, the rapid increase of audiovisual content (Massidda 2015) due to the advent and popularity of Streaming Video on Demand (SVoD) systems, has caused the so-called 'rise of subtitling', a phenomenon that a variety of scholars have addressed since its inception (Díaz Cintas and Anderman 2009; Perez and Jánošíková 2018; Massidda 2023).

In 2020, the outbreak of the Covid19 pandemic further intensified the pace of these ground-breaking transformations. In the past two years, the habits of

international viewers, "forced into strict measures of confinement and lockdown by governments around the world to respond to the planetary emergency, have changed profoundly, accelerating a process that was already in motion" (Massidda 2023). According to Shevenock (2022), the pandemic compelled SVoD platforms to broadcast older TV programs in new markets and languages largely due to the shutting of cinema screens, resulting in a growing demand for content localisation across the world.

Since then, LSPs worldwide have endeavoured to meet the needs of an ever-changing mediascape by implementing strategic global pools of professionals plugged into proprietary cloud-based solutions to improve efficiency and speed and to reduce costs: professional cloud subtitling is a localisation trend that defines a workflow conducted online through collaboration among subtitlers based in different geographical locations around the world (Díaz Cintas and Massidda 2019; Díaz Cintas and Massidda 2021).

3. New trends in AVT technology

The main functionalities of professional subtitling programs have undergone substantial improvements over the past two decades. At the turn of the century, LSPs worldwide (such as *Deluxe*, *Iyuno SDI Media*, *Plint* and *ZOO Digital*, to name but a few) started experimenting with new technologies by focusing their efforts on the development of proprietary subtitling software toolkits. Among the new features initially integrated into them were the audio waveform bar (to visualise soundtracks, noises, and voices), the automatic backup tool (to automatically save progress), the audio scrubbing feature (to listen to portions of sound frame by frame), shot/scene change auto-detection, automated quality control checks, and so on: the list is virtually endless. All in all, these added features allow professionals to boost their productivity and maintain consistency throughout the subtitling process (Díaz Cintas and Massidda 2019), and they have become absolute must-haves in professional processes nowadays.

As was discussed in Section 2, Web 2.0 unleashed an extraordinary series of epochal changes (Perrino 2009) allowing users to freely access web-based platforms and download open-source (OS) subtitling software. Traditionally, professional subtitling software has been relatively unaffordable for many translators, a fact that encouraged advanced users to start the development of near-professional subtitling freeware, such as *Aegisub*, *DivXLand Media Subtitler*, *Subtitle Edit* and *Subtitling Workshop*. The true potential of new technologies applied to AVT was further encouraged by faster Internet connections which gradually led to the 'cloud turn' (Bolaños García-Escribano and Díaz Cintas 2020). By virtue of cloud

computing technologies, a new virtual environment would host a plethora of applications that used to reside on users' machines, thus creating a truly ubiquitous and interactive environment. In the subtitling sector, web-based subtitling platforms were initially utilised for collaborative projects as in the case of *Amara* (amara.org), a crowd-subtitling initiative created to produce multilingual subtitled versions of TED Talks by volunteer translators, projects that are currently carried out on a proprietary cloud-based platform, *CaptionHub* (captionhub.com).

Nowadays, the greatest challenge in the AVT industry is represented by the increasing demand for localisation services "propelled by the rise in the demand for subtitles in the entertainment industry due to the advent of VOD streaming systems" (Díaz Cintas and Massidda 2019, 265) which has led to progressive reductions of turnaround times and budgets (Georgakopoulou 2012, 2018). The AVT sector is thus witnessing profound changes in terms of workflow management: LSPs mainly rely on global pools of subtitlers working on cloud-based subtitling platforms which provide access to a set of tools to cue, translate, review and QC subtitles, convert file formats if required, and embed subtitles on video files. Cloud subtitling platforms also incorporate project management interfaces to keep track of all projects through interactive workflows in real time.

Cloud-based solutions for the localisation industry have become the gold standard, as in the case of LSPs such as *Nordisk Undertext's Plint* (plint.com), *IYuno-SDI Media's iMediaTrans* (iyuno-sdi.com) and of SVoD companies such Netflix's Subtitle Originator (netflix.com). However, some cloud subtitling toolkits may be available on demand to general users, as in the cases of *eCaption* (ecaption.biz), *OOONA* (ooona.net) and *SubtitleNext* (subtitlenext.com), created by PBTEU, a hybrid platform that relies on a desktop-based software that communicates with the cloud-based tool associated to it. In some of these platforms, the transcription and subtitling phases are powered by Computer Assisted Translation (CAT) tools (e.g., translation memories, term bases and glossaries), as is the case of *CaptionHub*, which incorporates *Memsource* (memsource.com) and also ASR features for dialogue transcription (*Amazon Transcribe*), built-in machine-learning algorithms for auto-captioning and machine-aided translation systems (NMT) for post-editing-based workflows (e.g., *Amazon Translate*). These technological new trends and developments may represent a tool for empowering professionals working in the AVT sector. Yet, as was discussed in § 1, from a professional perspective, these developments may represent a real threat, ultimately leading to deprofessionalisation (Baños 2018). This issue deserves further consideration for the sustainability of the localisation industry.

4. ¡Sub! localisation workflows (th)at work

As was discussed in the previous sections and especially in Section 3, over the last few years the advent of cloud-based environments has simplified localisation workflows and has made it possible for virtual teams of professionals to work together remotely. However, while the technological turn has been relatively gradual in other sectors of the language industry, the process has been fast and unsystematic in the AVT sector, where it has encountered some criticism. Until now, most cloud-based platforms for dubbing and subtitling have failed to fully integrate CAT tools, spellcheckers, thesauri and so on, while the growing use of MT has come under scrutiny, for example in the recent *Machine Translation Manifesto* published by the Audiovisual Translators Europe Association (AVTE 2021). However, far from rejecting technology outright, AVTE translators point out that they are "in favour of the concept of the augmented translator that puts the human front and centre and uses technology to enhance their capabilities" (AVTE 2021). This is precisely the focus of the *¡Sub! Localisation Workflows (th)at Work* project, funded by UNINT and carried out in collaboration with Roehampton University and with the support of four industry partners, i.e., *OOONA*, *Captionhub*, *Matesub* powered by *Translated*, and *Sub-ti Ltd*. The project ran in 2020–2021 and was renewed for a further year (as *¡Sub!2*) in 2022.

4.1 Objectives

The rationale of the *¡Sub!* project is that, although AVT is a creative process, it includes some tasks which may lend themselves to automation, thus freeing up time and energy to focus on the truly creative aspects of translation. Thus, *¡Sub!* aims to investigate the role of automation in subtitling workflows, to raise awareness of potential pitfalls and to highlight how subtitlers can harness technology to increase productivity and efficiency.

More specifically, the project compared three different subtitling workflows in a series of experiments conducted in the spring of 2021. All the subtitling teams involved in the experiments (described in Section 4.2) experienced three workflows which differed in their degree of automation, with the 'traditional' workflow being carried out simply by means of the subtitling tools of a cloud-based platform, the 'semi-automated' one also integrating an ASR tool for automatic captioning, and the 'fully automated' one including both ASR and MT. The main goal was to identify the most effective workflow equation, namely the one that ensured the best quality output in the tightest turnaround time. By investigating such processes, the project also aims to pinpoint the training needs associated to the use of key translation technologies in cloud subtitling.

4.2 Methodology: Subjects, tools, and materials

The project was conceived as a one-year pilot and the experimental phase was to take place in March-April 2020, after carrying out desk research and software testing to select the most suitable tools and materials. Unfortunately, this coincided with the onset of the coronavirus pandemic and subsequent lockdowns, which considerably slowed down progress and forced us to rethink the whole project to be delivered entirely online, including the training sessions to be offered to participants before the experiments. In the end, experimental design, tool selection and subject recruitment were concluded by March 2021 and were followed by the experimental phase and data collection in April-May of the same year.

Twenty-four MA translation students and recent graduates from UNINT and Roehampton University were recruited to take part in our online cloud subtitling experiment, twelve of them to work in the English into Italian direction and the other twelve to work from Spanish into Italian. A pre-experiment questionnaire was administered to all the participants to collect information about their language profiles, their education, training, professional translation experience, AVT experience, and their expectations in taking part in the experiment. Each participant was allocated to a subtitling team and was assigned a role based on prior experience. Thus, participants were split into three subtitling teams to work from English into Italian and three subtitling teams to work from Spanish into Italian. Each subtitling team included a project manager, a spotter, a subtitler, and a reviser. Some key data on participants are presented in Table 1: subjects in the 'English' group were slightly older and more experienced than those in the 'Spanish' group, and most of the participants were women.

Table 1. Participants

Language pair	Average age	AVT experience	Gender
EN > IT	27	58%	11 F, 1 M
ES > IT	24	50%	10 F, 1 M

The experimental phase took 6 weeks (about 25 hours overall) and was conducted entirely online, thanks to a variety of tools. A course was created on *Google Classroom* for easy management and distribution of materials, which included organisational and procedural instructions (teams and roles, timeline and deadlines, workflow descriptions and technical information), reference materials (subtitling conventions, post-editing guidelines, quality assessment forms, logbooks, and so on) and, of course, the source materials to be translated.

Zoom was used for live meetings in the first two weeks of the project. In week 1 a live class was held to give participants an overview of the project, revisit the key aspects of subtitling (including technical parameters and subtitling conventions) and present and discuss the basic principles of post-editing NMT output. In week 2 the subjects received a 3-hour practical introduction to the *OOONA Subtitling Toolkit*, with a special focus on the *Create Pro* and *Translate Pro* tools to be used during the project. In week 3 participants were given the opportunity to work with the *OOONA* tools in their own time (for as long as they wanted) by subtitling some practice videos. Finally, in weeks 3, 4 and 5 the actual subtitling experiments took place.

For both source languages, the teams subtitled three 10-minute excerpts from a science documentary: this genre was chosen because it is (potentially) better suited to both ASR and MT. Documentaries usually feature a voiceover narrator and fewer overlapping voices and background noises than films or TV series; in addition, they are mostly scripted, which means that the language tends to be (relatively) standard. These characteristics usually result in better transcription accuracy, which, in turn, also facilitates the machine translation process. One of our industry partners in the project, *Sub-ti Ltd*, provided us with a working copy of two documentary films (one in English and one in Spanish) screened at the 2019 Turin *Cinemambiente* film festival.[1] The Italian subtitles produced by *Sub-ti Ltd* and used for the official screenings of the two films during the festival were taken as a benchmark of industry-level quality in the analysis of our data (see Section 5.2).

The experiments were conceived as simulations of subtitling assignments in which everyone had a specific role to play. In all the workflows the project manager had the task of distributing materials to the other team members (i.e., spotter, translator, and reviser) and collecting all the work they produced, as the teams were requested to submit not only the final TL subtitles for each clip, but also all the source language (SL) and target language (TL) files produced in the intermediate stages (first draft, second draft, and so on). The spotter oversaw the spotting list, which the translator then used to produce the TL subtitles. The reviser was tasked to check not only the linguistic aspects of the translations but also the technical parameters of the subtitles, and to fill in a quality assessment (QA) form at the end of the revision process. Finally, the project manager was responsible for the final quality control (QC) of all the materials before submission. However, as the source materials provided to participants in each workflow differed, the actual tasks carried out by each member of the subtitling team also varied slightly. In the traditional workflow (WF1) participants only received the video clip and the

1. The two films were *Do You Trust This Computer* (Paine 2018) and *Empatía* (Antoja 2017).

post-production dialogue list, which meant that the subtitling team had to carry out all the operations, including manual spotting, translation, and adaptation. In the semi-automated workflow (WF2) the team was provided with the video clip and the automatic SL captions generated by the *CaptionHub* ASR tool: the spotter had to check the captioning to detect any technical issues (e.g., time codes, subtitle duration, positioning in the presence of visual information, etc.) and to correct any transcription errors. Finally, in the fully automated workflow (WF3) participants were given the video clip, the SL automatic captions and the TL subtitles produced via the *MateSub* MT tool. In this case, the spotter had to check the SL subtitles (just like in WF2), while the translator had to carry out some post-editing of the NMT output. All the subtitling teams experienced the three workflows, but each one in a different order. As can be seen in Table 2, while group A started with the traditional workflow (WF1) and was gradually exposed to increasing levels of automation, group B began with the semi-automated one (WF2), then tried the fully automated one and finished with the traditional one; finally, group C began with the highest level of automation (WF3), shifted to the traditional workflow and concluded the experiment with the semi-automated one.

Table 2. Workflow order by subtitling group

Group	Week 4	Week 5	Week 6
A	WF1	WF2	WF3
B	WF2	WF3	WF1
C	WF3	WF1	WF2

To keep track of the work carried out by all team members in each workflow, participants were required to keep a record of every session in a dedicated logbook. They had to provide information on the time spent in each work session, any reference resources they consulted, the actual tasks they carried out, any linguistic and technical issues they encountered and the solutions they adopted. The form was made available to all the members of each subtitling group via *Google Classroom* and was meant to facilitate teamwork, as the participants were working remotely. Moreover, the form also enabled us to collect valuable research data.

Participants were instructed to record their screens during each work session via screencasting software (o*Cam*) and submit all the recordings, together with their subtitle files. In addition, the project managers were instructed to keep a record of any communication taking place among team members (e.g., emails, text messages, phone calls, videoconferences) and to write up a 'workflow summary report' to be submitted together with the logbook and all the other materials. Finally, at the end of the experiment, participants filled in a post-experiment

questionnaire in which they were asked to rate their performance, indicate which workflow had worked best and worst for them and describe the main problems they had encountered.

To sum up, different types of data were collected in the experiments:

1. Data on participants' education, skills, and prior experience (pre-experiment questionnaire) and on their self-evaluation after the experiment (post-experiment questionnaire).
2. Data on work sessions per group and per workflow, i.e., duration, resources, linguistic and technical problems (logbook data, workflow summary sheets, QA forms, and screen recordings).
3. Drafts and final versions of SL subtitles and TL subtitles (as .srt and RTF files with the Track Changes tool enabled, to detect any corrections made).

5. Data analysis

After describing materials, subject recruitment and experimental set-up, this section presents the preliminary results emerging from a quantitative and qualitative analysis of our English into Italian data, as the analysis of the Spanish data is still on-going at the time of writing. It is worth pointing out here that the subjects who subtitled the English documentary were all graduates from UNINT and the University of Roehampton with some translation experience (including in the AVT sector), ranging from a minimum of 3 months to 4 years, as shown in Table 1, Section 4.2.

5.1 Quantitative analysis

The aim of the quantitative analysis phase was to determine the most time-efficient workflow, both in absolute terms and in relation to each subtitling team. Therefore, the first step was to collect session duration data from all the logbook files and workflow summary sheets. The entries were checked against the screen recordings to detect any inaccuracies in filling in the logbooks. The few discrepancies that were identified were cleared up with the project manager of each subtitling team. All the data thus obtained were collated to calculate overall workflow duration by group and group average (as shown in Table 3, where duration is expressed in minutes and the order in which each group tackled each workflow is indicated in brackets).

The data in Table 3 can be commented in various ways. The first aspect that is immediately obvious is the huge differences in workflow duration among the

Table 3. Workflow duration data

Group	WF1	WF2	WF3	Average
A (WF 1,2,3)	1,227	976	696	966
B (WF 2,3,1)	625	874	694	731
C (WF 3,1,2)	1,312	759	1,067	1,046
Average	**1,054**	**870**	**819**	

three groups, ranging from a minimum of 625 minutes (group B, WF1) to a maximum of 1,312 minutes (group C, again WF1), with group B emerging as the fastest on average (731 minutes). This seems to indicate that team composition has the biggest impact on workflow duration. The data also tell us that any workflow tackled in the final week of the experiment was always the fastest, regardless of its degree of automation: for group A the fastest workflow was the fully automated one (696 minutes), for group B it was the traditional one (625 minutes) and for group C it was the semi-automated one (759 minutes). This would seem to indicate that improving teamwork and increasing familiarity with procedures and tools have a positive effect on duration, i.e., a 'learning effect'.

In terms of absolute values, the fully automated workflow (WF3) was the fastest on average (819 minutes), but when it was tackled in the first week it was not very time-efficient, as was the case with group C (1,067 minutes). Thus, it can be concluded that automation can only ensure time-saving when procedures and tools have been fully mastered by subtitlers. This, in turn, points to the need for training and adaptation when integrating ASR and NMT tools into a cloud subtitling workflow.

Finally, it is worth noticing that the smallest differences were found in the duration of the semi-automated workflow (WF2), which was 976 minutes for group A, 874 for group B and 759 for group C. In other words, regardless of team differences and the above-mentioned learning effect, the availability of automatic captions does seem to save some time and the integration of an ASR tool into the workflow seems to be relatively straightforward. However, working fast does not necessarily mean producing good quality subtitles. Therefore, the next step in the analysis was a qualitative evaluation of the output of the subtitling teams.

5.2 Qualitative analysis

The general aim of our qualitative analysis was to identify the workflow that ensured better quality subtitles. This was done by checking the quality of the final outputs submitted by the three subtitling teams (i.e., the TL subtitles) and com-

paring them with the benchmark subtitles used in the festival film screenings (see Section 4.2). Then, the quality assessment (QA) forms filled in by the revisers of the three teams were checked. The form required revisers to enter the number of linguistic and technical errors they encountered in the subtitles, to classify them and to describe the action taken to correct them. Table 4 shows the linguistic and technical error categories that were applied in the QA forms.

Table 4. Quality Assessment (QA) Form

Linguistic issues		
Category	**Errors**	**Comments**
semantics	2	Very good translation overall. All the changes were made for the sake of clarity.
punctuation	0	
use of the TL	12	
register	0	
terminology	1	
spelling	1	
line breaks	0	
morphosyntactic issues	0	
Total	**16**	
Technical errors		
Category	**Errors**	**Comments**
spotting (lack of sound synch)	0	Several time codes were changed to improve reading speed, as OOONA flagged several errors in red. Several commas at the end of subtitles were also identified and deleted, in accordance with the guidelines.
spotting (lack of synch in shot change)	0	
minimum gap between subtitles	0	
subtitling conventions	15	
reading speed	10	
subtitle length	5	
no subtitle for audio	0	
no subtitle for video	0	
Total	**30**	

Linguistic issues are errors which can be identified in the text of the subtitles. When the meaning of the SL expression was altered by a translation error, omission, or addition in the TL, this was classified as a 'semantics' error. Punctuation errors include both the absence of punctuation and punctuation marks used incorrectly (i.e., not in accordance with the guidelines). The 'use of the TL' cat-

egory refers to calques, wrong collocations, or phraseology. Register errors affect the level of formality of the target language (too formal or too colloquial). When a technical term is rendered incorrectly in the TL, that is classified as a 'terminology' issue. Finally, there can be issues with spelling, morpho-syntactic aspects, or line breaks, affecting subtitle segmentation. Technical issues concern the timing, duration and speed of the subtitles, their compliance with subtitling conventions, and the absence of subtitles in those cases when there was visual or audio information in the film (e.g., a sign, a caption or an excerpt from a TV or radio broadcast).

The TL subtitles submitted by each group for each workflow were analysed and the quality assessment forms filled in by the revisers were checked: this made it possible to identify further linguistic and technical errors that had been missed. When the data are presented by group and workflow, as shown in Table 5, it clearly emerges that many more errors were detected in the subtitles produced by all the groups in the first week of the experiment (28 for group A, 52 for group C and a whopping 69 for group B). Moreover, the number of errors decreased from week 1 to 3, regardless of the order in which the subtitling teams tackled the three workflows. This indicates that increasing familiarity with tools and procedures and improving teamwork had a positive effect not only on workflow duration (see Section 5.1), but also on quality.

The most accurate subtitles were produced by group A (21 errors on average), while the least accurate team was group B, with 41.6 errors on average. Interestingly, group B was also the fastest on average, taking almost 4 hours less than group A and 5 hours and 15 minutes less than group C. For reasons of space, the analysis of session duration per role was not reported in Section 5.1; however, it is worth pointing out that the work sessions of group B's translator were of a similar duration to the work sessions of the other translators, while the other members of her group (project manager, spotter, and reviser) worked considerably less than their counterparts in groups A and C. This was probably a contributing element to the overall lower quality of the TL subtitles produced by group B and further confirms the importance of the human factor when trying to assess the effectiveness of technology.

When the data on quality are presented by workflow, as shown in Table 6, what emerges is that on average the most accurate workflow was the 'traditional' one (WF1), while the fully automated workflow (WF3) was slightly more accurate than the partially automated one (WF 2). Moreover, there is a steep learning curve for both workflows integrating higher automation: when they were tackled first (groups B and C, respectively), this resulted in very high numbers of errors (69 and 52).

Table 5. Error analysis by group

		Linguistic errors	Technical errors	Total errors	Avg. errors	Avg. duration
Group A	WF1	21	7	28	**21**	**16h 06′**
	WF2	7	12	19		
	WF3	8	6	16		
Group B	WF2	47	22	69	**41.6**	**12h 11′**
	WF3	16	14	30		
	WF1	15	11	26		
Group C	WF3	42	10	52	**27.6**	**17h 26′**
	WF1	3	16	19		
	WF2	9	3	12		

Table 6. Error analysis by workflow

		Linguistic errors	Technical errors	Total errors	Avg. errors	Avg. duration
WF1	GR A	21	7	28	**24.3**	**17h 34′**
	GR B	15	11	26		
	GR C	3	16	19		
WF2	GR A	7	12	19	**33.3**	**14h 30′**
	GR B	47	22	69		
	GR C	9	3	12		
WF3	GR A	8	8	16	**32.6**	**13h 39′**
	GR B	16	14	30		
	GR C	42	10	52		

However, if group B is disregarded for a moment and considered an outlier (for the reasons outlined above in relation to team composition), workflow 2 emerges as the most accurate on average (16.5 errors), followed by the traditional one (23.5), while the fully automated one is the least accurate (34). In the final section, these results are discussed to present some conclusions.

6. Discussion and conclusions

The *¡Sub!* project had the overall aim of identifying the combination of human and technological factors able to produce 'workflows that work' in the localisation industry. A series of online experiments was carried out involving recent graduates and MA students from UNINT and Roehampton universities with varying degrees of AVT experience. Depending on their training and background, they were assigned to a subtitling team, and they were allocated the role of project manager, spotter, subtitler or reviser. All the subjects received the same training in the use of the *OOONA Subtitling Toolkit* and the same information and reference materials on procedures, guidelines, and conventions. A huge amount of data was collected during the project and the analysis is still on-going, which means that any conclusion presented here is to be considered preliminary.

When the results of the quantitative and qualitative analysis of the English data are considered together, some interesting patterns seem to emerge. Firstly, there was a clear 'learning effect' in all the subtitling teams and in all the workflows: all the participants worked better and faster in the final week of the experiment. This clearly indicates the importance of familiarity with tools and procedures, but also of teamwork. It is perhaps a foregone conclusion, but it is useful to bear in mind that an adaptation period and dedicated training are needed if considering a shift to remote work via a cloud subtitling platform. This applies especially to the integration of ASR technology and NMT tools. Not only do they not speed up the translation process immediately, but they initially result in higher numbers of errors, as subtitlers need to learn how to use such technologies efficiently and effectively. Accurate revision and quality control procedures are required to ensure good quality output. More specifically, dedicated training in post-editing NMT output applied to AVT is required to find a balance between over-editing (changing machine translation output unnecessarily) and under-editing (accepting the output as appropriate and accurate when it is not).

Clearly, the results of this study are limited in their scope. It will be interesting to see whether the same trends are confirmed by the analysis of the Spanish > Italian subset of data (and it is worth remembering here that the Spanish participants were MA students with considerably less translation experience than their English counterparts). A further step will be to compare the subjects' self-evaluations in the post-experiment questionnaires with data on the actual quality that was achieved. Moreover, an experiment on a sample of more experienced professionals is being considered in the follow-up to the project, to clarify whether similar patterns emerge in relation the integration of technologies into subtitling workflows.

By way of conclusion, it can be stressed that today's subtitling trainees certainly need advanced translation competences and practical training in the use of cloud subtitling platforms and key translation technologies. However, they also need to know how ASR and NMT tools work to make the most of them in translation assignments. What this small-scale study confirms is that technology is not much use unless those who are using it know what they are doing.

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