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Do we want to keep working in 12-h shifts? The follow-up of the work schedule change in a Portuguese industrial company

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ABSTRACT

Background: In Europe, atypical work schedules assume an increasing position, framed by the so-called “adaptability regime”. Despite being seen as a “temporary” option, this regime supports the extension of the working hours up to 12 h per shift.

Objective: The purpose of this study was to analyse how the workers from a Portuguese industrial company perceive the impacts of a 12-h schedule, after replacing the former 8-h shift schedule.

Methods: The sample included a total of 87 shiftworkers of an industrial company. A mixed method research was followed based on the ergonomic work analysis, using observations; a self-report instrument describing a week working on 2×12 h; and a questionnaire.

Results: Field study findings are consistent in showing that, in 2×12 h, the workers perceive the risks as resized, both physical risk factors (e.g., noise) and factors related to the work organization (e.g., work pace). The results also reveal a perceived aggravation of the main health outcomes: “sleep debt”, feeling of chronic fatigue, and muscles pains. Despite this, most workers prefer the new 12-h schedule, but not until their retirement age.

Conclusion: At present, it is noticed that the new schedule receives collective acceptance and is considered the least-worst option; the advantages outside work seem to compensate the higher costs imposed by this schedule.

Relevance to industry: Our findings highlight ergonomics’ contribution to the sustainability of the work in 12-h shifts, establishing the conditions that enable a technical-scientific opinion supporting the company’s decision on the exposure length of the workers to these work schedules.

1. Introduction

This paper presents an analysis to the implementation of a 12-h work schedule in a plant of the largest Portuguese beverages production and selling company. At the beginning of 2017, the 8-h schedule was replaced by a 12-h schedule, following the workers request, who argued the new schedule would give them more room for manoeuvre to reconcile work and the life demands outside work. This study emphasised the daily work and this specificity had the following objectives:

- analyse the perceived impacts of the schedule, particularly on health, offering visibility to a set of situations that, according to the workers, may be risk factors in 12 h.
- learn about the experience the workers build by dealing with the new 12-h schedule, when compared to the previous 8-h schedule.

The company implemented the new 12-h schedule during an experimental period of 12 months. They have then made a research request in order to follow the workers’ transition process from one time organisation (3×8 h) into the other (2×12 h), analysing the impacts perceived by the workers because of the 12-h schedule, compared to the 8-h schedule. The research was designed to answer the following question: to what extent is the 2×12 -h schedule a risk factor?

2. Theoretical background and the debate on working time “adaptability”

2.1. The atypical work schedules as a more and more “naturalised” resource

The topics of the duration and the organisation of the working time are constantly discussed in the European labour market, especially after

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the publication of the “Organisation of Working Time Directive” (93/104/EC), issued in 1993, and the subsequent revisions in 2000 and 2003 (Directive, 2003/88/CE). Over the last couple of years, the controversy around this discussion increased, on the one hand, in a context that favours work intensification scenarios (Burchell et al., 2009; Franke, 2015; Piasna, 2018; Volkoff and Delgoulet, 2019); and on the other hand, given the constant deadlocks regarding the statutory revision of the European norm. Despite the “prescriptive approach” of the European norm, limiting the number of work hours due to safety reasons, the last public consultation processes to revise the European Directive addressed the possibility to extend the “reference period” beyond the current 12 months (European Commission, 2015), if set by collective agreement, to calculate the average of working hours per week. Such an amendment would actually extend the term to accept extended work schedules.

In Europe, the organisation of the work time in shifts is gaining more and more prominence, as indicates data from the last European surveys on working conditions (Eurofound, 2017, 2019). In line with this trend, the interest in extending the duration of the shifts (up to 12 h per journey) is also increasing, especially in continuous operation contexts. The 12-h shifts are again at the top of the options for the organisation of the work time (Piasna, 2018). This schedule extends the work into unsocial hours in order to respond to organisational demands, but it might be also implemented following a request from the workers (e.g., Johnson and Sharit, 2001). The workers’ perspective is to look at the 12-h shifts as a better way to compromise on the demands of life outside work (Bendak, 2003; Loudoun, 2008). In other words, the workers get the feeling of “personal gain” outside the company (Cunha et al., 2018), or they perceive the freedom from the restrictions imposed by the 8-h schedule (e.g., less number of days off). In turn, the companies consider the 12-h shift as an effective choice to meet the demands of continuous operation, as it guarantees the activities are run nonstop, apparently saves “non-productive time”, and allows a higher maximisation of the existing equipment (Smith et al., 1998; Bendak, 2003).

Well, it is indeed true that the literature describes the advantages of 12-h shifts both from the companies’ and the workers’ point of view; however, those advantages are restricted to here and now (Ferguson and Dawson, 2012), under the principle that such an option is defined with a temporary status.

2.2. Work 12 h in the “adaptability” regime

With 12-h shifts, the companies keep working 24 h a day managing just two work shifts (2×12 h).

There are several 2×12 h schedules, which may be different in terms of: (i) the shifts’ start and end time; (ii) the teams (fix vs. rotating) and the shifts interchange (between day shifts, night shifts and days off); (iii) and the sequence of the rotation. Table 1 summarises data from nine scientific studies regarding the organisation of extended 12-h schedules, in different activity sectors, providing a comparative analysis that reinforces the variability of possible combinations.

These work schedules show differences in their internal organisation, for instance regarding the variability in the cycles’ extension, the time a shift begins or ends, or the number of consecutive journeys.

Implicit in the extension of the work duration offered by 2×12 -h shifts is the conception of human operation that assumes its maximum stability (Barthe, 2015), regardless of the hour of the day when the job is performed, the extension of the shift, or the number of consecutive shifts completed. Confronted with this scenario, it is up to the worker to adjust the (biological, social and family) life rhythms to the demands, pace and organisation of a 12-h work journey.

This adjustment has legal groundings. In Portugal, the 12-h schedules are legally framed in the so-called “adaptability” regime (Articles 203–207 of the Portuguese Labour Code). This is a regime that states the Regular Work Period (RWP) can be defined considering the average number of hours, within a reference period no longer than 12 months, exactly how the European Directive puts it. Consequently, on average,

the RWP may encompass up to more 4 h per day and at most 60 h per week.

When a 2×12 h shift is put into practice, the worker is expected to adjust to the schedule, compensating the effects of extending the journeys with a longer rest period between work journeys, when compared to the rest period that was provided in 3×8 h.

2.3. Is it just a matter of “getting used” to the 2×12 h schedule?

The workers covered by this type of schedules frequently experience situations of destabilisation or imbalance, caused by disagreements between the work time demands, the characteristics of human operation, and the social and family rhythms (Quéinnec et al., 2008). Such situations produce a resizing of the work demands, which may lead to the deterioration of the health and well-being condition, as well as to the destabilisation of the organisation of life outside the work context (Quéinnec, 2007; Toupin et al., 2015; Arlinghaus et al., 2019).

As a matter of fact, the “more frequent” rotation between night and day shifts in 12 h represents a physiological condition that is unfavourable for the body, causing the workers to face scenarios where they try their best to “get used to” the misalignment of the circadian rhythms to which they are subjected (Costa, 2010). As far as health is concerned, among the consequences reported the most, the sleep problems, the severe musculoskeletal complaints, digestive and gastrointestinal problems, chronic fatigue and change in cognitive functions such as attention, vigilance and short-term memory stand out (Prunier-Poulmaire et al., 1998; Harrington, 2001; Caruso, 2006; Tucker and Folkard, 2012; Marqué et al., 2014; Kecklund and Axelsson, 2016).

The research on how expressive these health complaints are shall not limit the analysis to the duration of the work shift, i.e., it shall take into consideration the characteristics of the activity. For that reason, in line with the scientific tradition of activity ergonomics and work psychology that confer priority to an analysis from the point of view of work (Daniellou, 2005; Guérin et al., 2007; Falzon, 2015), the research on the schedule must encompass the work content and organisation, together with its context. This exact approach will highlight not only the commitments made by the workers in 12-h journeys, but also the implications for health imposed by such schedule.

3. Materials and method

3.1. Organisational context

The research process took place in a production centre from the Super Bock Group, the largest Portuguese company in the production and selling of beverages.¹ At this plant, the analysis focused on the production area dedicated to bottle filling, whose continuous operation is guaranteed by four work teams that change every 12 h. By the time the analysis was carried out, each team encompassed 19 workers, divided into groups of four to six workers per filling line.

The organisation of the work time in 2×12 h was not unprecedented at this plant. Other productive areas had already experience in 12-h shifts, counting on a positive assessment from the workers, who emphasised above all the extra money for the extended work shift, the reduction of travel costs to and from work and the greater availability for the social and family socialisation.

¹ The identification of the company in this paper has been authorised, and reveals its concern and the will not to take the decision to change the schedule without a proper analysis to the actual work, the access to the workers’ point of view, and a technical-scientific opinion about the impacts of changing the schedule configuration.

Table 1
Studies reporting different 2 × 12 h shift rosters.

Activity sector	Country	Study (Year)	Shift beginning - end	Rotation cycle	Cycle extension
Health	France	Cheyrouze and Barthe (2018)	7am-7pm 7pm-7am	2 N-3R-2D D-R-2N-3R ...	35 days
Chemical Industry	UK	Tucker et al. (1996)	7am-7pm 7pm-7am	3D-3R-3N-3R	28 days
Oil and gas Industry	Brazil	Alvarez et al. (2010)	6am-6pm	7D-7N-14 R	28 days
			6pm-6am	7 N-7D-14 R	
		Fischer et al. (2000)	7am-7pm	2D-3N-4R	28 days
			7pm-7am	3D-2N-5R 2D-2N-5R	
Smelting Industry	Canada	Bourdouxhe et al. (1999a)	6:30am-6:30pm 6:30pm-6:30am	3D-3N-R-3D-3N-7R	54 days
	Australia	Baulk et al. (2009)	7am-7pm	2D-2N-3R	–
			7pm-7am	2 N-2D-3R	
Power Industry		Mitchell and Williamson (2000)	–	2D-2N-3R	112 days
				2D-3N-2R	
				5 R-2D	
				D-2R-2F-2D	
Paper, Pulp and Chemical Industry	Finland	Karhula et al. (2016)	7am-7pm 7pm-7am	2D-2N-4R ...	–
Mining Industry	Australia	Paech et al. (2010)	6am-6pm 6pm-6am	4D-4R-4N-4R	16 days

D – Day shift; N – Night shift; R – Rest period.

3.2. Design of study

With the company's institutional support, the plan to follow-up the implementation of the new schedule lasted for one year. Throughout that year, the analyses took place in the real context – based on the scientific contributions from work psychology under the scope of the interdisciplinary action of activity-centred ergonomics (Lacomblez et al., 2007).

The methodological plan combined three main stages presented in Table 2 below.

The research plan followed an activity-centred, bottom-up approach (Daniellou, 2005), dedicating a closer look to the analysis of the conditions that may be a risk factor in 12 h, and identifying the impacts of the current schedules configuration (2 × 12 h) when compared to the experience with the former schedule (3 × 8h). Thereto, given the creation of specific instruments to collect data ("Activity Diary"²), the research relied on specific temporal mediators: (i) the working conditions with the former schedule; (ii) the effects on health and well-being; and (iii) the look at health in prospective terms, with the 12-h work schedule.

3.3. Data analysis: interviews and questionnaire

The interviews lasted, on average, 1 h and 40 min; they were recorded and then transcribed by one interviewer and completed with the notes of the other. The sample included 20 workers from all the filling lines at the plant, aged 24–56 years old and with an average seniority of 12 years.

A thematic analysis was carried out to study the interviews, a qualitative method for the identification and analysis of patterns (or themes) deriving from the content (Braun and Clarke, 2006). The choice for this method intended to voice the reality, exactly as the workers understand and express it. This analysis was carried out in discussions among the research team.

Bearing in mind the question "to what extent is the 2x12-h schedule a

Table 2

Analysis stages and corresponding methods and instruments to collect data.

Methods and instruments	Collected data
Stage 1 Document analysis	- Characterisation of the history of work schedules in continuous operation at the company
Stage 2 Analysis of the work activity, using as resource observations (108 h) and statement records	- Characterisation of the work content and organisation
	- Characterisation of the teams constitution
	- Identification of job rotation strategies
	- Identification of constraints/critical points
Activity Diary (N = 20)	- Identification of unforeseen circumstances (e.g., team; machines)
	- Elements regarding management and quality of the sleep in each working day (e.g., no. of sleeping hours; interruptions)
	- Record of health complaints (e.g., fatigue; surveillance reduction)
	- Strategies of sleep regulation
Semi-structured interviews (N = 20)	- Professional experience in different schedules
	- Identification of protecting factors and risk factors in 2 × 12 h
	- Strategies of health preservation, applied at work and outside work
Questionnaire: work risk factors in 8-h and 12-h shifts (N = 61/92)	- Identification of the risk factors that are worsened in 2 × 12 h, in comparison to the 3 × 8h schedule
	- Identification of the main schedule-related health complaints
	- Perspective of getting the job done in the 2 × 12 h schedule beyond the experimental period, and up to retirement age
Stage 3 Group restitution and validation session with workers (N = 6) Group session with key players ^a (N = 9)	- Final map of the impacts perceived as a consequence of the schedule: for the activity, in health, and in life outside work

^a Session with members from the following areas: People Management; Occupational Health Service; Production Manager; Safety and Health at Work; Workers' Committee.

² Autocomplete instrument describing a week working on 2 × 12 h. For each day of the week, the worker characterised the workstation, the rotation process, the composition of the team, the health complaints, and the management and quality of the sleep.

risk factor?", the coding process divided the interviews into segments – those which emerged as pertinent considering the research question – that went through an interpretative analysis that enabled the extraction of themes (units of analysis), organised later on in a thematic map. This map represents the four identified overarching themes. The researchers discussed the themes until an agreement was reached and the codebook was developed during that process. The use of a codebook allows a more refined, focused and efficient analysis of the raw data in subsequent reads. The codebook was developed following the guidelines of Roberts et al. (2019). That is, during the codebook development stage, each theme, subtheme and data extract continued to be reviewed and moved until the researchers agreed on what determined sufficient demonstration of a true representation of a theme³. It is from these themes onwards that the subthemes were developed, describing the relationships and the intersections between the thematic units that were taken into consideration (Terry et al., 2017). The purpose of the map is to highlight that the workers' answers to the demands of the tasks and the perceived risks are mediated, on the one hand, by the work schedule (in 12 h); and, on the other hand, by a set of individual and group regulations established as "sources of balance at work" (Quéinnec, 2007; Barthe, 2009).

The qualitative data was complemented with the outcomes of the questionnaire. The process to collect data using this instrument, designed and filled online, was launched nine months after the implementation of the 2 × 12 h schedule. At this point, the respondents have already a considerable experience in the 12-h schedule. The purpose of using this questionnaire was to assess the workers' perception towards: (i) the risks at work; (ii) the impacts of a 2 × 12 h schedule on health and well-being; and (iii) the expectation of sticking to a 2 × 12 h schedule.

The questionnaire was sent to all the workers from the production centre (filling area), and the results demonstrate a 66% response rate ($N = 61$). The data underwent a statistic analysis through SPSS-Statistics 24, producing a summary statistic and bivariate logistic regression (Method = Enter). Hence, it was possible to determine the association between the perceived occupational risks and the workers' intention to keep the 2 × 12 h schedule. Consequently, we have tried to determine which risks factors are considered active players in the probability of occurrence of the values of the binary dependent variable under analysis: yes (value 0)/no (value 1). The probability of the dependent variable having the value 1 was then estimated, i.e., "I do not imagine myself working in 2 × 12 h until I retire", with a significance level $p < .05$.

4. Results and discussion

4.1. The organisation of the schedule 2 × 12 h vs. 3 × 8 h

The former schedule 3 × 8 h was organised into an 84-day cycle, recording the rotation between morning shifts (7:30am–3:30pm), afternoon shifts (3:30pm–11:30pm), night shifts (11:30pm–7:30am), and rest periods. Therefore, for each cycle, the schedule would have the following configuration:

5N-R-5A-R-5M-R-3N-3R-3A-R

At present, the 2 × 12 h schedule is organised in a 28-day cycle, reflecting the following rotation between day shifts (8am–8pm), night shifts (20 h–08 h) and rest periods:

3R-2D-2R; 2N-3R-2D; D-R-2N-3R; R-2D-R-3N

Table 3 shows a comparison between these two work schedules.

The implementation of the 2 × 12 h schedule brought the reduction in the number of work shifts per year, though, on average, the number of

hours of work per week is the same (42 h). On the other hand, even though the shifts are now longer, the characteristics of the 2 × 12 h schedule are, apparently, in line with some of the main criteria defined under the scope of activity ergonomics and chronobiology (Knauth, 1996; Kundi, 2003; Ferguson and Dawson, 2012). This schedule in 2 × 12 h registers the following conditions:

- the reduction of the number of work shifts per month (from 23 to 15).
- the reduction of the number of consecutive nights at work (from 5 to 3).
- the increase in the number of free weekends per year (from 13 to 26).
- the increase in the rest period after a sequence of night shifts (72 h or 96 h).
- the increase in the number of days off per month (from 7 to 15).

But do these days off compensate the effects that come with the extension of the daily work journey?

4.2. The perceived resizing about the occupational risks in 12 h

As stated beforehand, the extension of the work journey up until 12 h is compensated by a higher number of days off per month, so, on average, both in the 3 × 8 h and in the 2 × 12 h schedules the number of hours of work per week is the same. This finding does not mean, however, that the workers perceive the risks in the exact same way, either the physical risks or those resulting from the organisation of the work time in 2 × 12 h. Table 4 identifies the working conditions and demands highlighted as "highly risky" by the workers. It is on these items that falls a perception of amplification in 2 × 12 h.

Among the physical factors, more than half of the workers points out as an aggravated risk in 12 h: the noise (73.8%), have to stand for too long (67.2%), frequently have to go up and down (54.1%) and have to make intense physical efforts (52.5%). One common trait to all these risk factors is precisely their amplification reported by the workers in 2 × 12 h, i.e., the level of noise is not louder or quieter in 12 h when compared to 8 h, but a greater daily exposure (4 more hours per shift) resizes the constraint felt by the workers.

As far as the team composition is concerned, the perception of the need to be cautious about the situations when the team is not complete (unpredicted absence of a worker in the production line) is also more pressing in the 12-h schedule. In these situations, the absence of one element may be translated into the need to work at a higher pace, or to spend more effort following or supervising the least experienced workers, as identified in the thematic analysis of the interviews.

Fig. 1 shows the final thematic map after the analysis of the interviews. It illustrates the relation between the different thematic levels (meta-themes and subthemes). Four meta-themes have been identified (work organisation; work schedule; work-related risks; protective factors), the all four contributing for a better understanding of the experience built by the workers in 2 × 12 h, and their perceived effects.

The theme "work organisation" encompasses elements related to the work content (e.g., machine; type of bottle to fill) and the work team ("crew"). In fact, the number of workers per team was coded based on two overarching themes ("work organisation" and "work-related risks"), once it was addressed in both thematic contexts, as well as in the relation

Table 3
Comparative analysis between the two work schedules (3 × 8 h vs. 2 × 12 h).

	3 × 8 h	2 × 12 h
Average number of hours of work per week	42	42
Maximum number of consecutive shifts (day or night shifts)	5	3
Number of work shifts per month	23	15
Number of days off per month	7	15
Maximum number of consecutive days off	3	4
Number of free weekends per year	13	26
Number of work shifts per year	274	182

³ The researchers' agreement on themes was tested using nominal comparisons of absence and presence of themes. The researchers agreed on the four overarching themes.

Table 4

Physical factors	N (%)
Noise	
45 (73.8%)	
Stand for too long	41 (67.2%)
Go up and down very often	33 (54.1%)
Have to make intense physical efforts	32 (52.5%)
Factors related to the work organisation (rhythm and intensity; composition of the team)	N (%)
Unpredicted absence of team members	45 (73.8%)
the temporary workers	37 (60.7%)
Have to work at a high pace	31 (50.8%)

Percentage of workers who signal the aggravation of occupational risks in 2×12 h.

between them (cf. Table 5).

4.3. The perceived impacts on health

In the subjective assessment about the impacts of the 2×12 h schedule on health, the questionnaire items enabled a comparative analysis about the declared complaints: “it was severe in 3×8 h”; “it is more severe in 2×12 h”; or “it does not seem to be schedule-related”. Table 6 presents the six main health complaints reported by the workers, whose severity differs according to the work schedule.

The findings show a perception of aggravation of the main complaints related to the work in 2×12 h, especially muscle pains and

joints. That is, 3.3% of the workers (only 2 workers) reported this problem to be more serious in 3×8 h while 41% (25 workers) considered the problem to be more severe under the current schedule. This indicator is in line with the main risk factors considered by the workers (cf. Table 4): stand for too long, have to go up and down very often or make intense physical efforts. On the other hand, the issue about the overall discouragement/apathy is indicated as more present in 3×8 h rather than in 2×12 h. It may be explained by the reduction in the number of consecutive shifts in a week (five shifts in 3×8 h vs. three shifts in 2×12 h); and, consequently, by the now wider time window to manage the demands outside work.

4.3.1. Fatigue and sleep problems in 2×12 h

The complaints regarding fatigue and sleep problems, though mentioned with particular emphasis, differ in terms of the work configuration in a week working under the 2×12 h schedule. Depending on the number of shifts (night and day), the workers identify which weeks working under a 2×12 h schedule lead to more fatigue or in which do they sum a “sleep debt” (Barthe, 2015; Kecklund and Axelsson, 2016), trying to compensate such imbalance with a higher number of sleep hours in the week with more days off. Table 7 presents the results of the questionnaire regarding the workers’ assessment about the four possible working week configurations (corresponding to a 28-day cycle in 2×12 h), setting the weeks apart in terms of fatigue and hours of sleep.

The week with three consecutive 12-h night shifts (i.e., week 4) is reported as the week with less hours of sleep (by 62.5% of the workers) and, simultaneously, more critical in terms of accumulated fatigue (as pointed out by 73.9% of the workers). In contrast, the workers mention the week with only two day shifts, and with no night shift whatsoever (i.e., week 1), as the one when they try to compensate that “debt”, especially through an increase in the number of hours of sleep during the night (as reported by 78.5% of the workers). The irregularity in the number of hours of sleep and the poorer sleep quality (e.g., number of interruptions; fragmentation) during the periods with consecutive shifts ends up reflecting in the perceived fatigue, in particular when the sleep is diurnal. In order to face this resizing of the sense of fatigue throughout

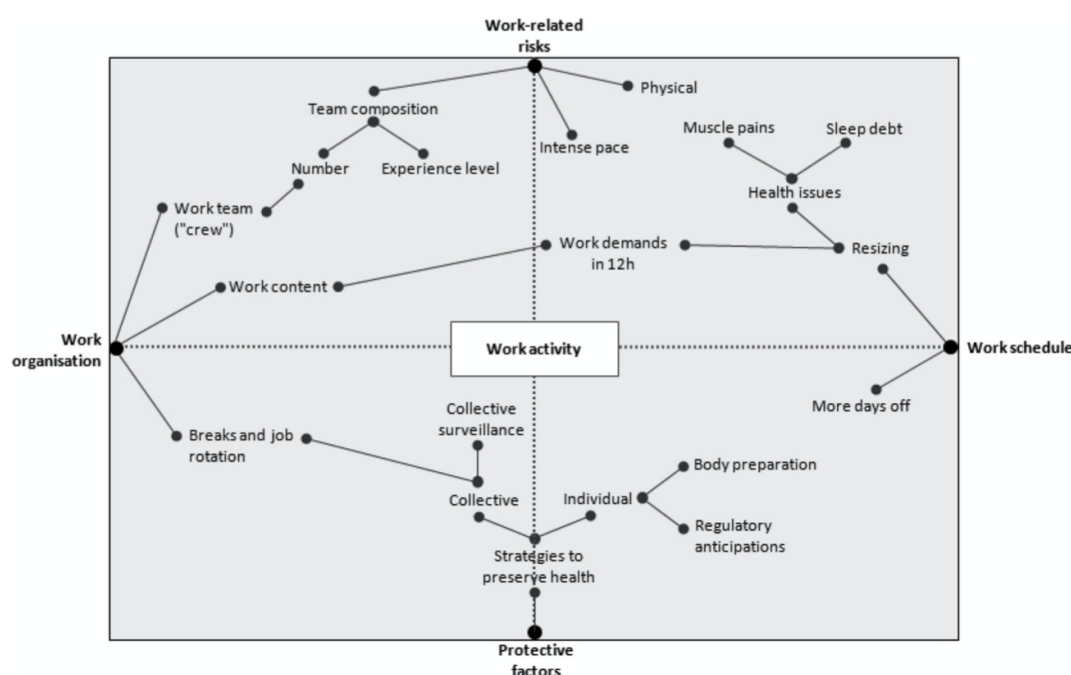


Fig. 1. Final thematic map, showing the connections between four meta-themes with subthemes listed for each.

Table 5

Extracts addressing the composition and the management of the work teams.

Theme	Sub-theme	Data extract
Work organisation	Work team: number	"The crew has 5 members, plus the team Coordinator and one temporary worker, who works at the first machine in the line, because he does not have so much experience" (40-year-old worker, 17 years of seniority, with experience in the 3 × 8h schedules with 3 teams, Monday to Friday; and 2 × 12 h) "Usually there are 6 of us on the line, but there are situations when a team member is missing and that was already complicated in the 8-h schedule. In 12 h, a missing element always implies effort, sacrifice. It is hard keeping the line in full flow when a colleague is missing" (34-year-old workers, 10 years of seniority, with experience in the 3 × 8h schedules with 5 teams; 3 × 8h with 4 teams; and 2 × 12 h)
Work-related risks	Team composition: number	"What happens now [in 2 × 12 h] is that we spend more time per shift in here, so if a crew member is missing, we will miss him the most at the end of the day, because we cannot fail and we will go the extra mile" (43-year-old worker, 18 years of seniority, with experience in the 3 × 8h schedules with 5 teams; 3 × 8h with 4 teams; and 2 × 12 h)
	Team composition: experience level	"There are weeks when we have on the team workers with different levels of experience, and that is exhausting because we have to be explaining everything all the time, the process, the equipment, the risks ... We lose focus, which should be on the job" (32-year-old worker, 11 years of seniority, with experience in the 3 × 8h schedules with 5 teams; 3 × 8h with 4 teams; and 2 × 12 h)

Table 6

Main health complaints registered, according to the work schedule - N (%).

	It was severe in 3 × 8h	It is more severe in 2 × 12 h	Does not seem to be schedule-related
Sleep problems	11 (18%)	15 (24.6%)	12 (19.7%)
Overall discouragement/apathy	14 (23%)	10 (16.4%)	7 (11.5%)
Overall fatigue	12 (19.7%)	24 (39.3%)	9 (14.8%)
Anxiety or irritability	11 (18%)	13 (21.3%)	10 (16.4%)
Muscle pains and joints	2 (3.3%)	25 (41%)	10 (16.4%)
Back pain	4 (6.6%)	20 (32.8%)	19 (31.2%)

Table 7

Working weeks in 2 × 12 h, according to the sense of fatigue and the number of hours of sleep - N (%).

	WEEK 1 3 R-2D-2R	WEEK 2 2 N-3R-2D	WEEK 3 D-R-2N-3R	WEEK 4 R-2D-R-3N
Severest week in terms of fatigue	2 (3.3%)	10 (16.4%)	5 (8.7%)	45 (73.9%)
Week with less hours of sleep	2 (3.3%)	14 (23%)	8 (12.5%)	38 (62.5%)
Week with more hours of sleep	48 (78.5%)	3 (4.6%)	4 (6.2%)	7 (10.8%)

D – Day shift; N – Night shift; R – Rest period.

the 12-h shift, the workers have developed strategies to preserve health and well-being (Toupin et al., 2015), aiming at either preparing the body for the 12 h or compensate the effects of the work after the 12 h. Table 8 shows some of the strategies that have emerged from the thematic analysis to the interviews (cf. Fig. 1).

These strategies aim at minimising the costs of shift work, though they are more notoriously focused on the recovery after the 12 h of night work. In fact, it is clear the investment in the days off to compensate the sleep debt, to recover from accumulated fatigue, and to prepare the body for the upcoming 12 h of work.

To sum up, the data sheds light on three aspects:

- the workers experience situations of "circadian readjustment" (Parkes, 2012), when the sleep changes according to the shifts' rotation cycle and the day sleep tends to be shorter and, for that reason, less deepen and reinvigorating (Costa, 2010; Marquié et al., 2014).
- during the night shifts, the circadian variations of functions related to surveillance and sleep reinforce the sense of fatigue (particularly visible in the R-2D-R-3N week), that increases along the shift (Axelsson et al., 1998; Barthe, 2009).
- the attempts to compensate the imbalances imposed by a 2 × 12 h schedule are visible in the higher number of sleeping hours in the rest periods, but also in strategies to prepare the body (cf. Fig. 1), implemented the most in the moments prior to night shifts, both in terms of preparatory sleep and meals (Baulk et al., 2009).

4.4. "Do we want to work in 12 h?" yes, but until when?

According to the results of the questionnaire, after nine months working under the 2 × 12 h schedule, 80.3% (N = 49) of the workers were in favour of extending the 12-h schedule beyond the so-called

Table 8

Extracts regarding the strategies developed by the workers to anticipate and/or compensate the effects of working in 2 × 12 h.

Theme	Sub-theme	Data extract
Protective factors	Strategies to preserve health: regulation of sleep	"In the last night I can only sleep 6 h during the day, so that I can fall asleep at night, and then I regulate my sleep in the [three] days off in a row" (24-year-old worker, 2 years of seniority, with experience in the 3 × 8h schedules with 4 teams; and 2 × 12 h) "If I have to sleep during the day, over the last hours of the [night] shift I avoid drinking, in order to avoid interruptions to my sleep" (54 year-old worker, 25 years of seniority, with experience with the 3 × 8h schedules with 3 teams, Monday to Friday; 3 × 8h with 5 teams; 3 × 8h with 4 teams; and 2 × 12 h) "In the last day off I cannot sleep 11 or 12 h, like I do in the second day off, otherwise I cannot fall asleep early that night, and the following day I have a [day] shift" (32-year-old worker, 10 years of seniority, with experience in 3 × 8h schedules with 5 teams; 3 × 8h with 4 teams; and 2 × 12 h) "Before entering the second night, I try to sleep until 6pm, no interruption, but sometimes it is just not possible. When that happens, I have to sleep one or 2 h before dinner time [7pm], and it helps me manage the fatigue around 3am onwards" (33-year-old female worker, 7 years of seniority, with experience in the 3 × 8h schedules with 4 teams; 2 × 12 h in another company and at the current company)

experimental period. When asked to justify this option, 54.3% of the workers refer the higher margin of manoeuvre to comply with the demands outside work, due to a higher number of days off. In addition, 19.6% refer they prefer to keep the 2×12 h schedule given the restrictions imposed by the previous schedule (3×8 h), which forced five consecutive work shifts every week and included more limitations in terms of days off (cf. Table 3).

Now, until when do the workers perspective the possibility to work in this schedule? Well, when the workers are asked to consider the viability of a 2×12 h schedule in the long term, for instance until retirement age, their answers are less unanimous (cf. Fig. 2).

In fact, 50.8% ($N = 31$) of the workers say they do not imagine themselves working in the 2×12 h schedule until retirement age, while 49.2% ($N = 30$) say they do. The latter is a more common opinion among the older age brackets (40–49 years old and 50–59 years old) (cf. Table 9).

Consequently, it seems age and stage of life are elements the workers consider when they weigh the pros and cons of the schedule; the closer the retirement age, the lower the perspective to spend time in the professional context, and thus in the 12-h schedule. For that reason, these workers (aged ≥ 40 years) seem more optimistic about the perspective of a 12-h schedule until retirement age. On the other hand, the workers feel already the resizing of the constraints in 2×12 h, which are loading with the effects of the exposure to previous schedules and reveal the perception of “professional wear” (Leroyer et al., 2018). As far as the younger workers are concerned (aged ≤ 39 years), it may influence their assessment about their ability to keep working in this work condition until retirement age. These results are in tandem with previous researches (Baker et al., 2004), which showed that preferred hours-of-work fluctuate for shiftworkers depending on years of experience. For example, for shiftworkers in their first 5 years of work experience, night work was a low priority.

In order to determine the risk factors perceived as aggravated in 2×12 h (cf. Table 4) and predictors over the fact that the workers do not imagine themselves working in this schedule until retirement age, we used the logistic regression analysis. Table 10 presents the findings, translated into Odds Ratios (OR).⁴

A close look at these results reveals noise and incomplete team are the risk factors that determine a higher probability for the workers not to imagine themselves working in the 2×12 h until retirement age. At the moment, the need to perform the work activity for 12 h with an incomplete team increases twice the probability of the workers not picturing themselves working in this schedule until retirement (OR = 2.18, $p = .036$). Work when the team is incomplete ends up influencing the amplification of other constraints, namely the increase in the work pace (e.g., have to guarantee the supervision of two machines at the same time); and the need to make more intense physical efforts (e.g., go up and down more often).

5. Conclusions

Bearing in mind the specific context under analysis, the debate about the best schedule is characterised by conflicts between health preservation and the reconciliation of work with personal and family life. In this case, it was defined the deliberation between two work schedules, so, at this moment, there was a collective acceptance that the new schedule is the “least-worst option” when compared to the previous 3×8 h schedule: the advantages outside work seem to compensate the higher costs imposed by the work in these schedules. But until when?

Lefrançois and Probst (2020), in a recent research with workers in transportation industry, highlighted that workers’ choice for a certain work schedule is not independent from the tensions between their family-related needs and the perceived costs for health associated to

their work. The trade-off between the two life dimensions – work and life outside work – is immeasurable and intrinsically related to the specific characteristics of the workers subject to these schedules (e.g., age; professional paths): the choice for a 12-h schedule may be particularly useful in certain moments of the workers’ life (e.g., with younger children) and while the effects on health keep a discreet, infrapathological expression. The analysis in the long term, however, reveals that developing the work under these terms until retirement age is less consensual. Therefore, in line with the findings of this study, we defend the need to extend the debate about “the best work schedule”. In this context, though all the workers consider the higher number of days off in 2×12 h an advantage, the younger workers’ perception that they will not be able to perform the work in 12 h until retirement age is a sign that cannot be neglected. These workers consider that working under such circumstances is not sustainable for themselves, though having certain advantages, for instance remuneration-related advantages, when compared to the employment conditions of other activities in the company (e.g. the case of the warehouse workers, who work in 3x8h shifts).

5.1. Recommendations and implications for future monitoring

Shall the 2×12 h schedule be kept or not? The heritage of knowledge we have so far under the scope of ergonomics and work psychology (Bourdouxhe et al. (1999b); Barthe et al., 2004; Tucker and Folkard, 2012; Barthe, 2015) alert for the aggravation of the health problems because of the work intensification that is inevitable in extended and more and more irregular schedules. Here is the paradox this study reinforces as well: the 12-h schedule presented in this paper fits the legal framework of the “Working Time Directive” and its definition is in line with recommendations that emerge from studies within the same scientific tradition we belong to (e.g., less number of nights at work). However, it is not true that the work experience in this time organisation is less susceptible to risks. On the contrary, the risks are resized in the 12-h schedule. Thereto, in order to diminish such “resizing” as much as possible, the workers defined under the scope of this research a set of suggestions to improve the working conditions. The company accepted those suggestions as recommendations to be implemented in the short/medium term:

- make available one hot meal during the night shift.
- beware of situations when one or two team members are missing, adjusting the filling plan to the number of workers who are actually present at the line.
- officially establish a higher number of breaks during the 12-h shifts.
- prevent work situations in isolation (avoid working alone, having colleagues to turn to, especially during the night periods).

Considering the implications of this research, we highlight two in particular. Firstly, even though the design and the implementation of a 12-h schedule comply with the rules of a provisional measure, we cannot neglect the conflicts the workers have to face regarding the requirements in the actual work activity. For example, the situations when the workers have to guarantee, simultaneously, the fulfilment of production goals and the follow-up to least experienced workers when the production is at its peak became even more crucial the moment the schedule was extended to 12 h. The company considered this situation and hired workers who formerly had contracts per service. In addition, the company created a recruitment pool with workers that are already familiar with the production process, the machines and the work risks, and to whom the company provides training in health and safety. These workers are called to replace those who leave for a short period of time (vacations; sick leaves) or to comply with unpredicted absences.

Secondly, addressing the intervention on the sustainability of a 12-h schedule, our action plan consisted in the definition of surveillance and assessment mechanisms, with a longitudinal nature, about the dynamic evolution of the effects the working time has at different levels of

⁴ The exponents of the regression coefficients (Exp(B)).

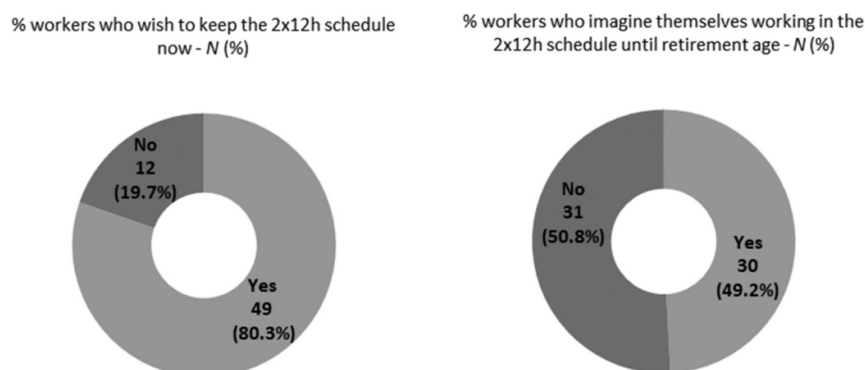


Fig. 2. The workers distribution according to the desire to keep the 2 × 12 h schedule now and up to retirement age.

Table 9

Distribution of the workers who imagine themselves working 2 × 12 h until retirement age per age bracket - N (%).

		20–29 years	30–39 years	40–49 years	50–59 years
“Do you imagine yourself working 2 × 12h until retirement age?”	Yes	2 (50%)	18 (58%)	6 (67%)	4 (80%)
	No	2 (50%)	25 (42%)	3 (33%)	1 (20%)

Table 10

Risk factors perceived as aggravated and the workers' probability not to imagine themselves working in 2 × 12 h until retirement age (95% CI).

Risk factor perceived as aggravated in 2 × 12 h	OR	p
Noise	1.21*	p = .036
Unpredicted absence of team members	2.18*	p = .039
Have to stand for too long	0.035	p = .646
Follow the temporary workers	0.24	p = .856
Have to go up and down very often	0.14	p = .852
Have to make intense physical efforts	0.84	p = .161
Have to work at an intense pace	0.66	p = .102

analysis: health (from pathology situations to complaints about changes in the sleep architecture and chronic fatigue); safety (risks caused by the work intensification); production and quality (adjustment of the goals according to the schedule).

Finally, this follow-up shall imply a joint analysis from different players within the company (occupational physician; safety technicians, workers committee), provided their involvement and participation is not only recommended by the European directive, but actually determinant for the definition of the limit when the agreement on the schedules ends.

Declaration of competing interest

None.

CRediT authorship contribution statement

Liliana Cunha: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Project administration. **Daniel Silva:** Software, Data curation, Visualization, Validation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Marta Santos:** Conceptualization, Methodology, Validation, Investigation, Writing - review & editing. **Cláudia Pereira:** Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - review & editing, Resources.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ergon.2020.102958>.

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