Comparative Study of Two Organisations Implementing Information and Communication Technology: Effects on the Health of Goods Transport Operators

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***Abstract*—The Road Transport and Logistics sector is subjected to strong competitive pressures within continuous changing socio-economic and regulatory contexts. These constraints have led companies in this sector to resort extensively to Information and Communication Technologies (ICT); these tools have both positive and negative effects on work conditions. Our hypothesis is that these effects depend on user ICT implementation, which is broadly determined by corporate organisation and management instructions. The aim of this study is to test this hypothesis in two companies organised differently (lean-type vs learning type) with an ICT since the last ten years, within an employee health and safety prevention scope. The main results reveal various effects related to using ICT. Weakening of inter-personnel relationships and a redistribution of interactions between operators were observed at company organised according to "lean-type organisation", while high pace of work and activity segmentation were noted in both organisations. Nevertheless, these preliminary results need to be confirmed with further studies involving others type of organisations.**

***Index Terms*—Information and Communication Technology, organisation, prevention**

I. Introduction

The Road Transport and Logistics sector is subjected to strong competitive pressures within continuous changing socio-economic and regulatory contexts. These constraints have led companies to resort extensively to Information and Communication Technologies (ICT). On the positive side, these tools promote higher productivity, goods traceability and error reduction. Their main negative effects, specifically affecting working conditions, are increased pace and intensity of work, closer activity monitoring (reduced employee independence), weakening of inter-personnel and/or group work relationships [3].

The ICT forming the focus of this study is the On-board Computer System (OCS), which is widely used in the road haulage sector. An OCS is defined as a system, which acquires, records and processes data mainly involving the driver, the vehicle and the transport operator. Based on requirements, these exchanges may also involve any external organisation that is useful or helpful in performing the work. The transport operator occupies a strategic position at the hub of exchanges between management, drivers and customers. Its activity hinges mainly around organising, planning and monitoring transport round trips. The operator is therefore responsible for selecting the vehicle based on the type of goods, for drawing up schedules and allocating drivers, and for fixing departure and arrival times. He also establishes delivery time windows and the delivery sequence when several recipients are involved in the same round trip. Moreover, during a transport operation, the operator becomes a supervisor by maintaining contact with drivers to provide support and new instructions, by monitoring orders on behalf of customers and by playing an active part in managing unforeseen events. It is the driver who executes the plan drawn up by the operator and The driver's job comprises several tasks [2]: transporting, in the safest and quickest conditions, products from one point to another (driving activity), ensuring transport-related administrative requirements (transport assignment order, delivery note, etc.), sometimes taking part in loading and/or unloading operations and arranging inspection of his vehicle.

Operators are expected to use the OCS as an aid to decision-making based on information including:

- Social data (for optimising driver driving and rest times, in accordance with regulations, and related transport planning)
- Technical data (for monitoring driving parameters, such as fuel consumption)
- Geo-localisation data (providing real-time information on route and vehicle geographical position)
- Goods management data (ensuring goods traceability).
- Beyond these 4 types of functionality, the OCS can complement existing means of communication for driver-operator exchanges.

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- From the driver's standpoint, the OCS can represent a navigation aid, a system for exchanging messages with operation management (transport assignment order transmission, customer address, etc.), an alarm system (lateness, authorised driving time exceeded, etc.) and a reference aid in organising working hours and rest breaks (social data).
- Our hypothesis is that effects associated with ICT usage are broadly determined by work organisation and management instructions. [1]. has effectively shown that the positive and negative effects of the ICT tool on logistics-based order preparers were not inherent to the tool itself, but resulted from interaction between the tool, the organisation, the activity and its user. The aim of this study is to verify this hypothesis for the transport operator position within an employee health and safety prevention scope.

For this purpose, we implement the following 4-class work organisation typology developed by Valeyre and Lorentz [4], [2] which is associated with models commonly described in organisational literature [6]-[9]:

- Learning organisations, in which employees frequently confronted with learning and unforeseen problem solving situations. They perform complex tasks, which are neither monotonous nor repetitive, and are subjected to pace-of-work constraints. These organisations require high level of autonomy with respect to work methods, pace of work and task sequence, as well as work-related initiative and communication.
- Lean production organisations are characteristic in a just-in-time context through adoption of practices such as team work, task rotation, total quality management (implemented using quality self-inspection and compliance with strict standards) as well as learning and problem solving. Employees have little room for manoeuvre in their work since they are subjected to multiple pace-of-work constraints imposed by automatic machine production rates or product flows, production standards to be achieved and direct line management control.
- Taylorian organisations combine very restricted employee autonomy (especially with regard to working methods), low cognitive content of work, task monotony and repetitiveness and heavily constrained pace of work. However, this type of organisation can be of a softer "flexible Taylorism" form, when employees work in teams or under versatile conditions.
- Simple structure organisations mainly feature only weakly developed formalisation of working procedures, team work practices, versatility and quality management . Constraints involving pace of work are relatively loose, while tasks are fairly non-repetitive but of low cognitive content. A control method involving direct supervision of employees by their immediate line managers exists in this type of organisation.

II. Method

To test this hypothesis, we selected to work with two road haulage companies for two main reasons. On the one hand, they had deployed a functionally identical OCS over a comparable period (10 years). On the other hand, their organisations were different. We compared the organisations of these two companies and how they used their OCS. Ergonomics-based research methods were implemented.

- Interviews were held with company management and operators. Resulting data enabled us to exemplify the main criteria adopted by Valeyre and Lorentz to categorise the type of organisation deployed in the two company operating departments. A interview guide was therefore edited to collect data on the following criteria: autonomy in work methods and rate, task cognitive content (problem solving, learning of new elements and task complexity), quality management (compliance with strict standards or quality self-inspection), task monotony, pace of work (imposed by machines, quantity to be produced, line management or colleagues), existence of group work, Potential for task rotations, and task repetitiveness

Based on the data provided by the interviews and observations, "weights" were allocated to the above criteria on a scale ranging from (-3) to (+3).

At the same time, management interviews enabled us to highlight a number of factors involving the strategies implemented by these companies for remaining competitive.

- Operator activity was formalised on the basis of data provided by interviews and filmed observations. Cameras were placed to film the workstation, in particular the computer monitors. In parallel, operator communications and explanations concerning their activity were recorded. In addition to the above information, data on operator activity were coded by experimenters in real time. This included:
- Coding of task performed by the operator (round trip structuring and monitoring, data entry, stock control, etc.)
- Coding of persons with whom the operator communicates (customer, driver, operations manager)
- Coding of communication method (oral, telephone, OCS, etc.)
- Coding of task performance medium (hardcopy, OCS, transport management software, email, freight exchange, MS Office pack, nothing)
- Coding of incidents-events
- Video images, audio recording and activity coding were synchronised to the same timescale using CAPTIV© software (Fig. 1). Data

acquisition was conducted for three days at each company.

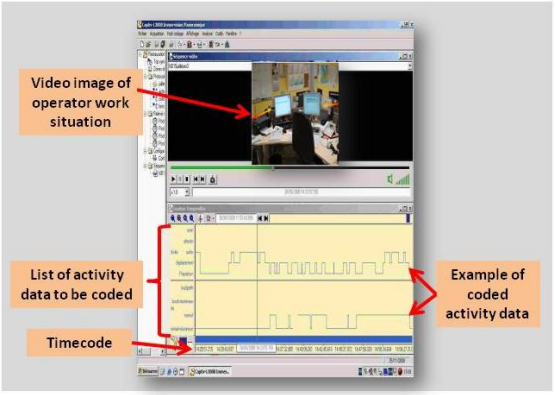

Figure1 Captiv interface

A. Data Analysis

All data were subjected to analysis, but only those concerning the four main negative effects of using an ICT, referred to in the introduction to this communication (increased pace and intensity of work, closer activity monitoring and weakening of relationships between personnel and/or work groups), are presented here. The study aim for this communication does not include the advantages of these tools and these are therefore not considered in the following.

III. Results

The operations departments at the two transport companies, referred to as L51 and P45, were staffed by an operations management and two operators. The L51 operators worked independently but shared the 80 company drivers. The P45 operations department was organised differently: the operator tasks were interdependent (one operator controlling company driver outward rounds, the other controlling return rounds). This company employed 60 drivers. Both companies were specialised in regional transport (80%) but undertook both national and international transport to a lesser extent (20%). Both companies possessed an OCS, which has been used by operators and drivers.

A. Categorisation of Company Operations Department Organisation

TABLE I. Example Criteria From Valeyre and Lorentz Model for Identifying Organisation Type

Categorisation criteria	L51		P45	
	Weight	Explanatory data	Weight	Explanatory data
Autonomy in working methods	0		(-) 2	Process to be monitored
Autonomy in work rate	0		0	
Task cognitive content: problem solving	(+)1	Presence of incidents and degraded situations for which there is no procedure	(+)1	Presence of incidents and degraded situations (no procedure available)
Task cognitive content: learning new elements	(+)1	Customer request variability	(+)1	Customer request variability
Task cognitive content: task complexity	(+)2	Diversified customers, less shuttles, half-pallets	(+)1	Tasks distributed among departments
Quality management: compliance with strict standards	(+)1	Road haulage regulations, constraints	(+)3	Rad haulage regulations, constraints + internal procedures + daily evaluation by line manager and general management
Quality management: quality self-inspection	0	Inspections, if problem	0	Inspections by other departments even if no problem and some self-inspection
Task monotony	0		0	
Pace of work imposed by machines	0		0	
Pace of work imposed by quantity to be produced	(+)1	Defined by activity and customer request	(+)1	Defined by activity and customer request
Pace of work imposed by line management	0		**(+)1**	by activity and line management request
Pace of work imposed by colleagues	0		**(+)1**	Outward-return interdependence
Existence of group work	0		**(+)1**	Outward-return interdependence
Potential for task rotations	(-)1	Only by replacing sick leave, etc. and activity peaks	**(-)1**	Only by replacing sick leave, etc. and activity peaks
Task repetitiveness			0	
Type of organisation	"Learning" type		"Taylor tending to lean"-type	

Based on data provided by interviews and observations, "weights" were allocated to the different criteria to categorise the type of organisation implemented in the two operations departments (Table I). The results show that the L51 operations organisation was rather closer to a learning-type organisation: Operators performed tasks integrating a significant cognitive content involving problem solving activities prompted by incident occurrence, for which there was no specified procedure. Moreover they learned new elements in view of the variety of customer requests and transport situations, which effectively governed their pace of work. The more customer requests and the more complex the requests, the more the pace of work accelerated in the L51 operations department. Apart from issues relating to transport regulations, there was no particular quality procedure-based control except in certain problem situations (disputes). The results for the P45 operations department show that its organisation is more of the "Taylor tending to lean"-type. The organisational characteristics described for L51 are generally encountered in P45. On the other hand, the

level of autonomy of P45 operators is low and their room for manoeuver is narrow, while the quality management level is higher and the pace of work is not only dictated by the quantity to be produced, but also by line management and colleagues.

Interview analysis shows that L51 management had implemented corporate strategy based on transport "monthly profitability evaluation". Profitability was calculated by the operations manager and discussed with the human resources manager. Together, they broadly defined what needed to be improved and their ensuing directives were subsequently transmitted to all operators.

The P45 management elaborated a different strategy based on financial indicators. The "daily earnings" of the operators' activity and of each transport operation was monitored by the operations manager, and then discussed with the managing director. Adjustments required to achieve the production targets defined by the managing director were then discussed and passed directly on to the relevant operators. Whether it be for L51 or for P45, these calculations were based on data provided by the OCS (diesel consumption, itinerary followed, etc.).

B. OCS Usage

The results show that the frequency of OCS usage by operators was fairly low and virtually identical (5% for L51 and 8% for P45). It was used for an average 19 seconds at both companies.

The difference between the two operations involved organising the usage of data provided by the OCS. At company P45, analysis of OCS data was indeed partially outsourced to department other than the operations department, while this was not the case at company L51.

C. Increased Pace And Intensity of Work

The frequency at which operator tasks change represents the indicator used to account for increasing pace and intensity of work. The results show that operator tasks changed every 52 seconds to 1 minute, on average, at both companies. This task alternating cycle shows that tasks, which have been started, are interrupted in order to continue or finish other tasks, depending on needs and environmental demands. This result is interesting in health and safety terms because returning to an interrupted task is attention-consuming. In the end, psychological fatigue may appear more of less quickly. It may be concluded that operator activity is sustained in pace-of-work terms, but an increase in these criteria cannot be concluded since no reference exists for the activity performed by these operators in a "no OCS" situation.

D. Increased Activity Control

The results show that the operators at company L51 spent 22% of their working time performing driver activity monitoring tasks using the OCS or telephone, compared with 14% at company P45. Activity monitoring tasks took longer at L51 (51 seconds) than at P45 (27 seconds). Qualitative assessment of explanations provided by these operators reveals that the monitoring tasks were no the same at the two companies. At company L51, monitoring tasks mainly involved ensuring "driver activity support" via oral data transmissions concerning customers to be delivered, their specific characteristics or the quality of customer-driver relations. Moreover, OCS-based driver location data are mainly used when the customer wishes to know exactly where its goods are or else if incidents occur. At company P45, these activities involve, to a greater degree, OCS-based "driver activity checks" on itineraries followed, delivery completion times or compliance with regulations. These results reveal that OCS usage for monitoring tasks is effectively corresponds to the different objectives at these two companies, which are partly determined by the organisation and strategy of each company.

E. Weakening of Inter-Personnel And/or Work Group Relationships

Inter-personnel and/or work group relationships are apprehended via operator communications (time, frequency) between themselves or with other work contacts.

Communication time represented 48% of operator activity at company P48 and 49% at company L51.

- The P45 operators were interdependent as previously emphasised. This means that they have to exchange information and coordinate at least when delivery rounds are transferred from outward to return. We therefore expected the communication level between operators to be greater at company L51, but this was not the case: the results show that the inter-operator communication time was virtually identical at both companies (43% frequency and 25% of time at L51, 40% frequency and 24% of time at P45). This result can be interpreted as an indicator that work inter-personnel relationships were more "important" at L51 than at P45.
- Communications between operators and drivers were more frequent and represented more activity time at L51 (28% frequency that is the number of communications identified) , 26% time that is the duration of communication among all communications identified) than at P45 (20% frequency, 17% of time).
- At company P45, analysis of OCS-based data was partly outsourced to a department other than the departments that use them; this was not the case at company L51. Outsourcing leads to fragmentation of information between different departments. This operating organisation changes the relationships between employees by reducing commonly observed interactions between operators and drivers, for example, and by "prescribing" other interactions, e.g. between drivers and human resources. At company P45, certain tasks usually performed by the operators (driver assignment expenses, disputes, OCS-detected offences, etc.) were hence transferred to human resources. A change in relations between

these three job functions could then be observed. For example, the operators addressed the drivers by their surnames, while first names are conventionally used. Similarly, previously un-noted tensions arose between drivers and human resources and between human resources and the operators, when dealing with offences in particular.

These qualitative results could be interpreted as revealing a transformation in inter-personnel relationships and creation of a distance between operators and between operators and drivers at company P45. The results for company L51 reveal less profound transformations in inter-personnel relationships.

IV. Discussion and Conclusion

We are aware of the limits of this type of qualitative approach. Nevertheless, we believe that these results reveal various effects related to using OCS in these two transport company operating organisations. Weakening of inter-personnel relationships and a redistribution of interactions between operators were observed at company P45, while high pace of work and activity segmentation were noted in both transport operations. This difference is interpreted as reflecting the different organisational modes implemented by the two operations. Hence, the strategy adopted at company P45, underpinned by production traceability logic (daily monitoring of several indicators) and its "Taylorian tending to lean"-type organisation would effectively modify operator activity in the manner described in our results. The "learning"-type organisation of company L51, particularly the higher level of autonomy and the lower level of operator control, would enable some of these effects to be overcome, such as relational distancing between operators and between operators and drivers.

Use of an OCS, a powerful and inescapable tool in the transport sector, has both positive and negative effects on the activity of its users. The combining power of these effects depends on the organisation and corporate strategy within which the OCS is deployed. In health and safety terms, this finding could prompt companies, equipped with an OCS or during deployment thereof, to reflect on how its negative effects could be curtailed as far as possible and its advantages optimised. These results need to be refined and tested in the transport sector; however it may be reasonably considered that this prevention approach would prove valid for all ICTs.

V. Future Work

These preliminary results need to be confirmed with further studies. This would compare to other companies that have or not the same modes of organization. A reflection in the future work should also address methodological aspects including how to acquire data quantitative nature to better highlight the effects of ICT

References

[1] V. Govaere, "Warehouse picking in logistics," *Hygiene and Safety at Work*, n. 214, INRS, 1st Quarter, 3, 2009.

[2] A. Valeyre, "Forms of work intensification and economic performance," in *French Manufacturing Eastern Economic Journal*, vol. 30, no. 4, Fall, 2004.

[3] Klein and T. et Ratier, D. Impact of ICTs on Working Conditions-Report and Documents from the French Government's Center for Strategic Analysis, 2012.

[4] E. Halter and E. Adolphi. (2006). Conducteur poids lourd de transport de marchandises. Bosson futé [Online]. Available: http://bosson-fute.com/Fiches/fiche0001.php?type

[5] A. Valeyre and E. Lorentz, Forms of Work Organisation in the Countries of the European Union, French Centre for Employment Studies, 2004.

[6] P. Zarifian, "A quoi sert le travail?" La Dispute, Paris, 2003.

[7] J. P. Womack, D. T. Jones, and D. Roos, "The machine that changed the world," *New York, Rawson Associates*, 1990.

[8] H. Mintzberg, "Structure and dynamics of organisations," *Éditions d'Organisation*, Paris, 1982.

[9] J. P. MacDuffie and J. Krafcik, "Integrating technology and human resources for high performance manufacturing: evidence from the nternational auto industry," in *Transforming Organisations*, Kochan et M. Useem M. Eds., New York, Oxford University Press, 1992, pp. 209-226.

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