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Workers' intervention authority in Italian 4.0 factories: autonomy and discretion

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Abstract

The present contribution aims at investigating the relationship between the introduction of Industry 4.0 technological innovations and the ensuing implications for workers' skills composition, their empowerment, and their authority of intervention in the work process, within three Italian firms exhibiting a wide range of organisational practices: from Japanese Toyotism, to a mix of Taylorism and co-determination, up to the example most akin to the German 'Mitbestimmung'. By distinguishing between the notions of discretion and autonomy in identifying the spheres of workers' intervention authority, our findings corroborate the presence of hybrid workforce empowerment, reflected into an increase of workers' discretionary intervention, and the lack of a similar increase in terms of autonomy, the latter meant as the possibility of establishing their own routines.

JEL classification: L23, L6, M54, O33.

Keywords: Industry 4.0, Technological Paradigms, Organisational Change, Lean Systems, Autonomy, Discretion.

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1 Introduction

It is widely recognised that the introduction of new technological paradigms is generally accompanied by organisational transformations (Nelson and Winter, 1982; Osterman, 1994). If the adoption of new technologies represents a change within the workplace, to what extent and in what sense does this change increase the ability of the subjects to intervene in the work process? The present contribution aims at investigating the relationship between the introduction of Industry 4.0 technological innovations and the ensuing implications for workers' skills composition, their empowerment, and their authority of intervention in the work process. By intervention authority we mean the extent to which workers are entitled to actively regulate the work process (see Maggi, 2016; Reynaud, 1988). Our study focusses on three Italian firms exhibiting a wide range of organisational practices: from the Japanese Toyotism (Toyota Material Handling Manufacturing Italy SpA), to a mix of Taylorism and co-determination (Ducati Motor Holding SpA), up to the example most akin to the German 'Mitbestimmung' (Automobili Lamborghini SpA).

Far from wishing to evaluate whether a potential 'Fourth Industrial Revolution' in the Italian manufacturing industry is currently underway, it is widely acknowledged that the technological conditions underlying I4.0 are (i) automation, (ii) digitalisation and (iii) interconnection (see Brynjolfsson and McAfee, 2014 and Ford, 2015, among others). These three basic technological conditions can be embodied in a multiplicity of technological artefacts, such as collaborative robots, big data analytics, internet-of-things, and cloud computing. With differing degrees, forms, and purposes, the case studies analysed in this contribution are affected by the adoption of I4.0 artefacts. At the same time, there is evidence that the organisational changes accompanied with the adoption of I4.0 technologies find a pattern of general continuity with the lean production paradigm (Womack et al., 2007). In a way, the I4.0 wave is fostering the leanness of the production system and hardly represents a paradigm shift. In fact, the 'new' I4.0 tension towards customisation, reduction of inventories, elimination of bottlenecks, tracking of errors, intensification and saturation of working time, and in general of process and organisational innovation, all constituting common traits of the firms under study, overlap remarkably with the first wave of lean production begun in late 1970s (Jaikumar, 1986). However, the intensification of market competition and demand stagnation following the Great Recession have further exacerbated these patterns. On the basis of this premise, and therefore of the objective introduction of technological innovations that have taken place over the last few years, the analysis is aimed at investigating the extent to which such innovations enable workers' authority of intervention within the work process.

As acknowledged by recent contributions (Albano et al., 2018), most studies focussing on the implication of technical change associated with Industry 4.0 and regulation of work processes clearly lack of sound empirical evidence, partly due to the absence of adequate data. A notable exception thereof for the German automotive industry is Pfeiffer (2016). With the present contribution, relying on a qualitative methodology based on field-work interviews to workers, union delegates, and middle management, we aim at filling the existing empirical gap in the literature.

By distinguishing between the notions of *discretion* and *autonomy* to identify the spheres of workers' intervention authority in the work process, our findings corroborate the presence of a hybrid process of I4.0 adoption which is reflected into a likewise hybrid process of workforce empowerment. Our results can be summarised as follows: the introduction of I4.0 artefacts has produced (i) a general increase of workers' intervention authority on the work process in terms of discretionary decision making; (ii) the lack of a similar increase of intervention capacity in terms of autonomy of workers, especially regarding the possibility of establishing their own rules in the organisational and production processes. Overall, a misalignment between organisational levers meant to 'extract' values from workers and those meant to 'redistribute' value to workers strongly emerges.

The paper is organised as follows. The next section briefly discusses the main themes that intersect in this work, namely the relationship between I4.0 technology and 'empowerment' of the workforce, defined in terms of workers' intervention authority by means of three distinct organisational levers. Section 3 presents our methodology regarding the field-work data collection and their subsequent analysis. Our results are outlined in Section 4 and further discussed in Section 5. Finally, Section 6 concludes.

2 Theoretical framework

In the present section we shall briefly outline the three cross-cutting themes which interrelate in our study: technology and firms (Section 2.1), authority of intervention (Section 2.2), and the three organizational levers (Section 2.3).

2.1 Technology and firms

The ultimate goal of introducing I4.0 technology within the production process is to achieve productivity gains. However, according to a widespread managerial rhetoric, by exploiting the possibilities offered by New Advanced Technologies (NATs, see Zuboff, 1988), firms have the opportunity to become *agile* and *smart*, reducing waste, encouraging the formation of collaborative working systems, and optimising the inter-organisational relations of the so-called 'industrial ecosystems'.

In this respect, one of the topics which the debate on I4.0 has focussed on is competences and tasks that the Fourth Industrial Revolution will replace with NATs, those that will survive in so far as they are compatible, and those that will be redesigned from scratch.[1] Although current and future trends still appear uncertain (Magone and Mazali, 2016), there seems to be agreement that the full exploitation of the potential offered by NATs can not but have as a necessary condition the increase in responsibility and involvement of all the figures present along the production process.

After all, the well functioning of an organisation is not simply based on employees' obedience, but rather on

> "[e]mployees taking initiative and applying all their skill and knowledge to advance the achievement of the organisation's objectives." (Simon, 1991, p. 32)

To properly characterise the nature of technology, we shall adopt the *recipe* perspective: technology entails a list of 'ingredients', namely procedures and admissible acts, required to build an artefact. A recipe always embodies a degree of codified knowledge (the ingredients) and non-codified or tacit knowledge (the non-written procedures). Together with the accomplishment of the recipe, the production of artefacts implies a process of coordination between members of the organisation. The ensemble of the recipe, the embodied knowledge required by its execution, and the coordination of members of the organisation, constitutes the organisational routines. These latter act as *trait d'union* between technology and organisation (Dosi and Nelson, 2010). This characterisation of technology links the design, adoption (integration), and use phases within the organisational process (Masino, 2011). A definition of this type avoids the risks of 'reification' (i.e. the vision of technology as a *datum* and not as a choice) and the temptation to alienate technology from the organisational process, or to consider it a 'background element'.

Granted this notion of technology, we characterise our unit of analysis, the firm, as a hierarchical entity wherein knowledge is differently distributed among organisational units and individuals, and the introduction of technological innovation entails processes of uneven learning and adaptation of the different hierarchical layers, in tune with the capability-based theory of the firm (c.f. Coriat and Dosi, 1998; Dosi and Marengo, 2015; Marengo and Dosi, 2005; Winter, 1997). Together, a smaller but insightful strand of organisational literature (Maggi, 1990, 2011, 2016) provide insights on the co-evolution of knowledge with respect to hierarchies and work organisation. Both streams of research conceptualise the role of power as

> "the ability of some agent (the 'ruler', the authority) to determine the set of actions available to the other agents (the 'ruled') [or even] the ability of the authority to influence the choice within the 'allowed' choice set."
>
> (Dosi and Marengo, 2015, p. 4)

2.2 Authority of intervention: autonomy and discretion

In the present contribution, by intervention authority we mean the extent to which workers are entitled to actively regulate the work process. Differently from most of the organizational literature,

[1] See Kenney and Zysman (2019) for a complementary discussion on the platform economy.

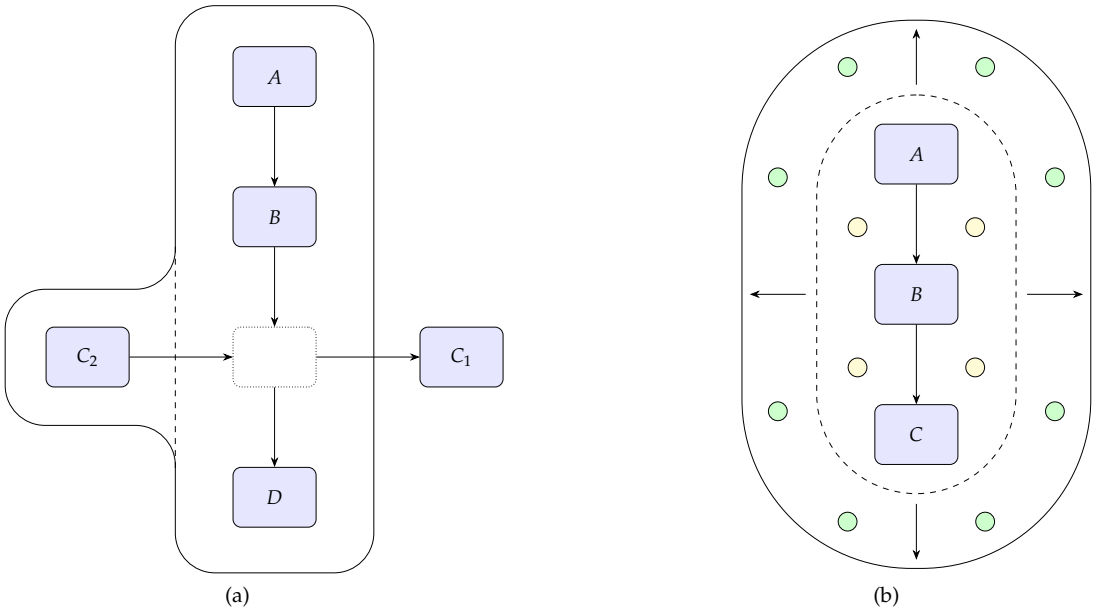

Figure 1: Graphical representation of autonomy (panel (a)) and of discretion (panel (b)).

we analytically distinguish two spheres of intervention authority, namely autonomy and discretion. We define the latter as a variable margin of action in a regulated process. The variability of discretion is therefore given by the breadth of the action space whose boundaries are however somehow already regulated. With the concept of autonomy, instead, we mean the production of own rules and

> "autonomy can not be granted or attributed: it can only be affirmed or conquered."
> (translated from Maggi, 2011, p. 75)

and it may either oppose or supplement heteronomy. Indeed, work processes reflect a permanent dialectic between heteronomy and autonomy. Workers might demand management to recognise their rules, and such a recognition might be substantive, or might entail forms of knowledge absorption and appropriation.

Fig. 1(a) shows a visual representation of autonomy. Let us consider A, B, C, and D as production phases and the solid line as the border defining the set of possible actions. When autonomy is exerted, the subject has the possibility to reshape the border (set of actions), which might be crossed by acquiring a new external phase (C_1) and discarding an old one (C_2). Note that the exertion of autonomy also allows the definition of the order in which the phases are completed. In this sense autonomy is an expression of ruler's power, because it enables the modification of the set of actions.

Fig. 1(b) shows a visual representation of discretion. Let us consider A, B, C as production phases and yellow circles as the individual tasks required to accomplish them. The increase of discretion entails the possibility to perform new tasks (green circles), with an expansion of the set of actions from the dashed boundary up to the solid one. Note that an increase of discretion does not allow to modify the set of actions: the border always maintains the same shape. The exertion of discretion is instead a manifestation of power underwent by the ruled, who is subject to the influence and authority of the ruler.

The distinction between these two notions appears particularly relevant to understand e.g. the principles of *autonomation* and *autoactivation*, the two pillars of the Ohnist production method, consisting in the ability of workers to detect a non-conformity, stop the process, and perform quality control. We shall see later how the specific forms of workers' activation put in practice by the firms under study primarily entail an increase in discretion. Note, however, that in both cases an increase in the required repertoires of actions occurs (Coriat, 2001).

The question that then deserves investigation is in what respect are workers equipped by authority of intervention when facing the introduction of I4.0 technology. Herein, the extent to which

the enabling of intervention authority occurs in terms of an increase in the autonomy of actions, or rather in terms of a general widening of discretion, is far from obvious.

It follows that linking the characteristics of the ability to intervene in the work process to supposedly intrinsic characteristics of the technology (for example technological artefacts referable to I4.0) is misleading. Instead, of relevance is the organisational dimension within which technology is placed. As a matter of fact, the combination of organisational/technological transformations is the core of all those socio-economic transformations that historians have called 'industrial revolutions' (Landes, 1969).

2.3 Organisational levers

It is no coincidence that many studies identify the processes of organisational adaptation to technology I4.0 as a fundamental condition for the full exploitation of the potential of NATs; as it is no coincidence that the proposals for organisational adjustment that the various researches and analyses formulate are always oriented to increase the knowledge of the production process and the self-activation (often defined *proactivity*) of workers through the development of systems of involvement and responsibility. In other words, the premise for an increase in proactivity of the subjects, is to accompany the I4.0 technologies with an organisational change, generally identified with the development of the principles of *lean production* (Womack et al., 2007). Within the literature, there exist multiple definitions of the latter, and it has been noted that the concept of 'lean' referring to organisational transformations has progressively assumed a vague and nuanced character (Arlbjørn and Freytag, 2013). With no ambition of offering an exhaustive definition, in the present paper by lean production we identify the set of organisational practices inspired by the principles of *lean thinking* (Womack and Jones, 2003), which concern both the ways in which production activities are planned and carried out, and the modes through which managerial activities are exercised.

In this regard, Osterman (1994) identifies the broader notion of *internal labour market* as the set of organisational practices aimed at improving the production performance of firms by making the organisation of work flexible and streamlined, in order to promptly respond to sudden changes in orders. The notion of flexible work organisation is identified in Gittleman et al. (1998) as any departure from the traditional and hierarchical production method in which workers have a precise role. This set of practices, called *High Performance Work Practices* (HPWPs), include: self-managed teams in which the workers self-supervise their work, presenting extensive decision-making autonomy in the event of errors or stasis of the process; problem solving groups in which the operators are directly involved in the problem solving process; job rotation, which manifests as the opportunity of moving between the various workstations and units of production; total quality management, which emphasises the role of teamwork; mechanisms of feedback and lean communication among the workforce. Bailey (1993) identifies three pre-conditions for the proper functioning of such practices, in particular: (i) workers must have knowledge and skills regarding the process that are not possessed by managers; (ii) workers must want to collaborate and therefore enhance their know-how; (iii) the organisation must be consistently structured to enhance the discretionary contribution of the workers involved.[2] The adoption of such practices has generally been described by the literature as a win-win game: on the one hand, the company enjoys productivity gains; on the other hand, the worker has the opportunity not only to benefit from a more flexible internal labour market, which allows easier mobility and career advancement, but also from direct participation with her own ideas to the production process. In this sense, Osterman (2000) finds that HPWPs have seen an increase in diffusion between the 1990s and 2000, even among American companies; however, in the same period there have been a stagnant wage trend and an increase in workers' perception of insecurity of employment. Therefore, it is also important to investigate the extent to

[2]Clearly, there are some corporate characteristics that influence the adoption and the degree of penetration of these practices. For instance, (i) the market competition level in which the firm operates, (ii) the scope of the competition, whether local or international, (iii) the type of product sold with respect to its degree of customisation, (iv) the technological complexity of the artefact in use and to what extent it requires the adoption of more or less lean practices, (v) the set of corporate values related to the structure of the properties (e.g. whether it is more family- or market-oriented) and (vi) the degree of unionisation, are all factors that influence the choice of adopting such practices. However this contribution it is not intended to carry out a comparison between companies with respect to the presence/absence of such practices, but rather to understand how such practices are perceived.

which 'gains are shared'. According to the results of Osterman (2000), the adoption of such practices within U.S. companies is associated with a higher probability of dismissal and no increase in wages; rather, they resulted in forms of internal restructuring implemented by firms.

The analysis presented in the following pages focusses precisely on the characteristics of some organisational changes inspired by the principles of lean production, definable as organisational levers affecting the intervention authority: (i) de-hierarchisation and development of teamwork; (ii) introduction of job rotation practices; (iii) introduction of assessment and career systems.

2.3.1 De-hierarchisation and development of teamwork

A dimension of organisational transformation often regarded as decisive for the exploitation of new technologies is the streamlining of corporate hierarchical structures. The increase in importance of the monitoring and data collection functions, the self-activation (proactivity) within the man-machine relationship, the multi-functionality and the responsibility of the operators, can only imply a strengthening of teamworking, and the rethinking of the hierarchical forms typical of the Taylorist organisation.

Starting from these considerations, it is considered appropriate to accompany the introduction of I4.0 technologies with lean management forms. In particular, the development of lean leadership forms is considered a central factor for a more general organisational transformation (Mann, 2009), and not by chance the functions exercised by the team leader (and in general the transformation of the functions of both the middle and the top management) represent a pillar of hierarchical restructuring, as they should allow the creation of a 'horizontal system' for the coordination of work practices, the management of workers without authoritarianism, and the development of their competences and responsibilities (Camuffo, 2017; Paris and Giustiniano, 2018). Unlike traditional command-and-control leadership which implies the authority to order subordinates on how to intervene in the production process, lean leadership is characterised by being more focussed on managing the responsibilities of operators who fall under the leadership of the leader (Shook, 2008). In accordance with this mainstream managerial literature, responsibility management should not be declined in terms of *laissez-faire* or results-only-oriented coordination, but rather as constant support for the development of problem solving skills by the operators, a strongly process-oriented coordination. This definition of leadership therefore includes practices of coaching, teaching and mentoring, the assignment and definition of responsibilities, the evaluation of results, and the definition of work programmes. In other words, lean leadership can not be simply understood in terms of top-down or bottom-up decision-making processes, but rather in terms of

> "taking responsibility for making decisions already taken and implemented [by others]." (ibid., p. 3)

For a team leader to carry out all the aforementioned functions, and thus effectively manage the team for which she is responsible, it is however necessary that she possesses specific personal characteristics in terms of values and behaviour (see the literature review in Van Dun et al., 2017), and specific skills (typically defined in the managerial literature as *transversal* or *soft* skills) (Angelis et al., 2011).

It is legitimate therefore to interpret the role of the team leader and of teamworking as levers of Taylorist de-hierarchisation, such as to highlight that the team leader, as well known, is not a hierarchical figure (Cerruti, 2015, p. 49). However, it is not possible to exclude from the empirical analysis the possibility that, through the figure of the team leader, new hierarchical forms will regenerate, nor to conclude that the latter, in case they emerge, represent a sort of deviation from an 'original lean model'. It is therefore possible, without resorting to the concept of dysfunctionality, to explain why, even though the

> "figure of the team leader struggles to embody the figure of a hierarchical superior [...] a certain discomfort of the workers emerges with respect to the undefined boundaries of the position of the team leader [...] [and because] [...] the figure of the team leader turns into a sort of 'boss', that is, in a subject who exercises the role of hierarchical superior without having received formal investiture." (translated from Corazza, 2015, p. 83)

2.3.2 Job rotation practices

Specialisation *vs*. rotation of the workforce in the organisation of the workplace is a well known trade-off for human resources departments: while Adam Smith already emphasised the role of specialisation in favouring the accumulation of increasing returns to scale, the practice of rotation between various workstations, but also between various departments, is widely recognised as boosting the productivity of workers (among others, Aoki and Rosenberg, 1989).

Generally speaking, the practice of job rotation turns out to be a mechanism that allows the company not only to respond to change, but also to 'produce' change (Aoki, 1990). This is the result of the acquisition of knowledge by the workers not only of a single phase, but of the entire production process. This enables the individual worker to intervene in several stages of the production process, whether errors occur, or if they wish to bring improvements, transferring ideas and experience from one location to another or from a unit/department to another. Of course, the practice of job rotation is the basis of the post-Fordist system, which replaces the maximisation of productivity through economies of scale (Fordism) with just-in-time production. In this sense, the typical worker inside the post-Fordist factory must have a large set of skills (Coriat, 2001). While the worker must be multi-skilled in terms of capacity, she possesses an unusual power with respect to the Fordist method, in that she can interrupt the line in case of error. On the other hand, as claimed by Coşgel and Miceli (1999), being the job rotation a worker-initiated innovation, there must be an organisational substrate, i.e. a set of sufficient preconditions that allow the workers to value their knowledge. It is necessary that there is an organisational structure that provides for and allows the worker to participate independently in the process.[3]

The introduction of job rotation practices is attributable to two conceivable goals by the management: on the one hand, job rotation represents an opportunity for workers to learn the details of the production process (*employee learning*); on the other hand, it represents a mean for reducing the degree of repetitiveness of the task being performed, and thus serves as a motivational mechanism (*employee motivation*).

Within the employee learning theory, firms benefit from the rotation of workers not only because the learning process that results enables productivity gains, but also because it makes the production process more streamlined and less dependent on the service of any single worker. It follows that in the event of a sick leave or vacation, the task of the single operator can be easily performed by someone else, increasing the overall degree of substitutability between workers.

Under the employee motivation idea, the firm benefits from motivating and making the tasks more dynamic for the so-called *plateaued* workers, whose career prospects are slim and feel 'rewarded' by a continuous change of tasks. While the evidence of job rotation practices serving the purpose of employee motivation are scarce in the American literature, this is not the case for Japanese firms. In fact, the application of these practices differs between the archetypal Japanese model and the American one. While in the former, although aimed at achieving lean production, job rotation systems (and in general the phenomena of participation in the production process, teamworking, and continuous improvement of processes) are accepted by workers on the basis of a 'pact' which corresponds to their knowledge, security in the working condition, and improvement of wages (life-long employment, growth of salaries based on seniority, etc...), within the latter the adoption of HPWPs is associated with processes of restructuring of the workforce (and not only of the organisation). For example, Fujimoto (2001) reports that Toyota identified a key strategy in improving the ergonomics of workers through the introduction of the *kaizen* (continuous improvement process), by including both a system of evaluation of the degree of workload, posture, and ergonomics (Toyota Verification of Assembly Line), and a series of collaborative machines (raku-raku seats, wagon carts, body-lifting mechanisms, etc...). Conversely, in the U.S. these practices have been accompanied by both the first wave of contingent hiring and the replacement of elderly with younger labour.

While under both the employee learning and employee motivation perspectives the worker is the first to benefit from job rotation practices, Ortega (2001) recognises that it is rather the management (*employer learning*) that can profit from learning whether value added is to be traced to a specific task, and hereby come to know whether some departments are more productive than

[3] As an extreme example, Aoki and Rosenberg (1989) report how the typical Japanese firm was a coalescence of single autonomous individuals, rather than a proper organisation.

others, or to a specific operator and her personal skills. Therefore, alongside job rotation practices are often added compensation schemes linked to individual performance (see next section).[4] Another element of interest consists of the complementary nature of the newly implemented systems. Job rotation practices are more prevalent when teamwork mechanisms are already in place, since the latter reduces the cost of the former, and, at least initially, result in a possible reduction in the output and/or malfunctions within the production process.

2.3.3 Evaluation and career systems

Evaluation and career systems have gradually gained importance within the organisational literature and the organisational theory of the firm. There are two instrumental factors by means of which the introduction of evaluation and career systems affect workers and their job performance: motivation and incentives. The attention towards the introduction of evaluation and career systems in fact does lever mostly on motivational factors that would bring workers to be more productive on the job, both directly and indirectly, by generating obedience, docility, and attachment to their role and to the organisation.

As part of organisational sociology, theories of motivation developed among others by Herzberg (1974), Maslow (1954), McGregor (1960), and Argyris (1970) have identified the 'human factor' as a carrier of complexity, and organisations are likely to thrive only if they are able to develop and enhance their human resources. It is a paradigm shift also in the theory of business management, in that the employee, from being a simple officer in performing tasks and duties, becomes a key factor for business success. From that moment, the organisation is recognised as a potential place of non-adversarial co-existence of the objective dimension of the firm with the subjective dimension of the workers, who bear material and psychological needs of self-realisation. In this context, from a management human resource narrative, the creation of an internal labour market is crucial to the very existence of the organisation.

The existence of career paths within firms can be approached in relation to the broader trend of the theories of non-monetary incentives. In this sense, the existence of appropriate incentives has been recognised as a major factor by which an organisation is able to increase the performance of workers. Non-monetary incentives are designed to reward job performance through access to so-called 'opportunities' which can manifest themselves in greater authority, prizes, participation to company management, better working conditions, various kinds of rewards, and especially career promotions and the promise of upward mobility (Hijazi et al., 2007). According to this literature, although the motivation of the employee can not be considered to be the main determinant of job performance, it can contribute to the construction of a 'proactive' attitude and adhesion towards the organisational culture of the firm (Lawler, 1971). This perspective, which ultimately goes back to the conceptualisation of a pyramid (Maslow, 1954), identifies with the incentives (including the possibility of career advancement within the plant), the motivating factors that lead workers to a greater degree of involvement and improvement of performance. Similarly, García-Izquierdo et al. (2012) emphasise that perceptions with respect to promoting systems directly impact on the perception of organisational justice and of work motivation/satisfaction. Koch and Nafziger (2012) add that promotions are desirable as they lead us to work harder, offsetting individual 'inefficiencies'.

All this draws the attention of the literature also on performance evaluation systems that should result in career progression. According to the theory of *goal setting* (Locke and Latham, 1990), the objective should be shared, clear, and precise, so that it can exert a positive influence on motivation and in turns on performance. Similarly, an evaluation system effective in motivating can not be separated from its intelligibility with respect to general management expectations, the criteria for performance evaluation, and the achievement of objectives. Likewise, the more or less discretionary character of the evaluation might negatively affect workers' motivation. Indeed, despite the feedback can be either negative or positive, what emerges from the studies in this field is that the presence of transparent systems of evaluation tends to have a positive effect on workers' performance.

[4] Among the factors that characterise firms adopting job rotation schemes, two elements seem to be of interest: (i) younger workers tend to rotate more (providing evidence against the employee motivation and more in favour of the employee learning); (ii) firms adopting complex technologies are more likely to implement job rotation.

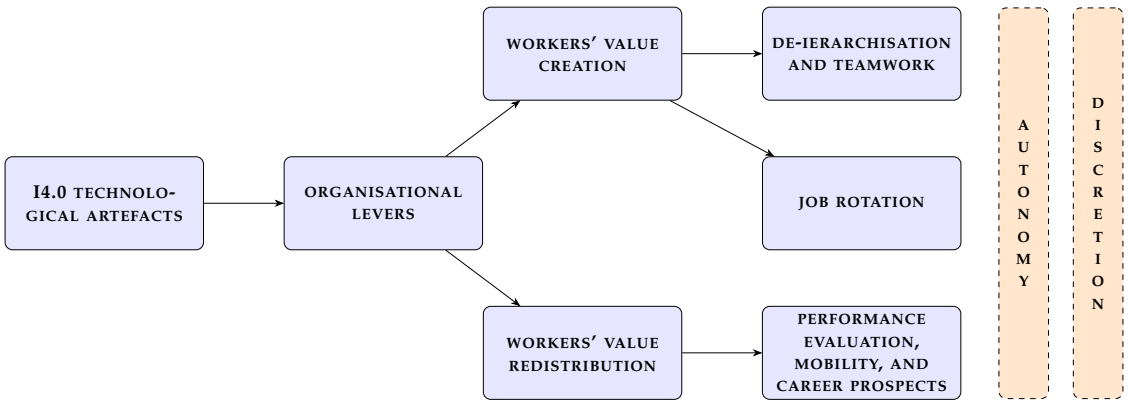

Figure 2: The research design flow.

From the capability-based theory of the firm, the existence of mechanisms such as career paths and evaluation systems enabling workers' identification in the organisation can be ultimately considered as an exercise of power, given the hierarchical authority-ridden nature of the firm. The most subtle exercise of power concerns the influence of the authority upon the preferences, and therefore the identification alignment of workers and managerial objectives might be a central element for the development of adaptive learning and coordination (Milgram, 1974). In tune, Dosi and Marengo (2015) underline that docility offers the inclination to

> "depend on suggestions, recommendation, persuasion, and information obtained through social channels as a major basis for choice" (Simon, 1993, p. 156)

Therefore, the implementation of mechanisms to reward or punish appropriate or inappropriate behaviour fosters not only what one can do, but more importantly, what one wants corresponding to self-perception and identity of agents (Dosi and Marengo, 2015).

3 Research objectives and methodology

The present work aims at analysing the implementation of the three aforementioned organisational levers (de-hierarchisation and teamwork, job rotation practices, and evaluation and career systems) and how they affect the intervention authority following the introduction of technological practices related to I4.0. As can be seen from the outlined theoretical framework, the aim of the work is not at detecting deviations in the implementation of the three organisational levers from ideal models, but rather at detecting the relevant features in their concrete manifestation. This allows to detect the characteristics of intervention authority while opening up the space to other interpretative paradigms. The research design flow is illustrated in Fig. 2.

Our analysis is based primarily on semi-structured interviews carried out within three automotive firms located in the outskirts of the city of Bologna (Emilia-Romagna, Italy): Toyota Material Handling Manufacturing Italy SpA (formerly known as Cesab, hereafter Cesab-Toyota), Ducati Motor Holding SpA (hereafter Ducati), and Automobili Lamborghini SpA (hereafter Lamborghini). The three cases are examples of companies which borrow practices, systems, and models ranging from Japanese Toyotism (Cesab-Toyota), a mix of Taylorism and co-determination (Ducati), up to the example most similar to the experiences of German *'Mitbestimmung'* (Lamborghini). Table 1 provides a picture of the current implementation of I4.0 technology within these firms.[5]

[5]The study of these three companies is part of a larger research programme (started in 2016 and still ongoing) of the Claudio Sabattini Foundation, commissioned by FIOM-CGIL (one of the leading Italian trade unions) and involving researchers from several universities and research institutes. The main purpose is to understand the main changes concerning the organisation of work and working conditions that occurred in recent years with the introduction of technological practices related to I4.0. In line with the general objectives and methodology of the research programme, we decided, supported by experts, union leaders, and other scholars in the field, to select a few engineering firms

Cesab-Toyota	Ducati	Lamborghini
◇ digital utensils (e.g. torque wrenches) and their data analytics ◇ digital internal communication via tablet computers ◇ 3D printers for prototyping ◇ ERP software	◇ digital utensils (e.g. torque wrenches) and their data analytics ◇ partial paperless factory ◇ 3D printers ◇ pick-to-light ◇ virtual configurators ◇ AGVs ◇ collaborative robots	◇ IoT and machine-to-machine connections ◇ big-data analytics (early phase) ◇ MES software ◇ AGVs ◇ collaborative robots

Table 1: The implementation of Industry 4.0 technologies within our case study firms.

The three case studies considered in this paper started with a series of discussion groups among researchers and union delegates of the underlying firms. The discussion groups (around 3, each consisting of about a dozen people) had the following objectives: preliminarily exploring the issues under study with union representatives; reconstructing the layout of the plant and its workflow; identifying potential interviewees; building the relevant access channels for researchers. Access of researchers to the firm premises had been therefore mediated by trade unions. However, the sample of interviewees was designed to include also non-unionised workers and to be balanced with respect to the various departments.

Subsequently, semi-structured interviews with the identified candidates were carried out. In this paper we analyse a set of 31 interviews with workers at the three plants, distributed according to Table 2. Interviews were conducted at the production plants in areas made available by the company or by union delegates. The interview activity was preceded by a visit to the different areas and departments of the plant; this represented a good opportunity of directly observing the state of technology in place and the organisation of work. In parallel, 6 other interviews were conducted with the management of the companies and other technical figures, the selection of whom varied depending on the specific characteristics of the plant. The interviews also gave us the opportunity to collect business documents and other publications relevant to the current research.

The collection of this material lasted for about one year and has given rise to a *corpus* of text on which, starting from the theoretical framework illustrated above, we carried out the analysis through a coding system inspired by the *Grounded Theory* (Corbin and Strauss, 1990; Glaser and Strauss, 1967). This process entailed a parallel and cross analysis (between the researchers involved) not only of the interviews, but also of the relevant literature and the material collected during the investigation, including secondary data derived from direct observation. The collected material had been in fact read and analysed in different moments of the research process, first independently by each author, then through dedicated comparisons during collective sessions.

Consistent with the outlined methodology, the interviews, the collection of other informational material, and the process of analysis did not follow a principle of statistical representativeness, but rather of concepts saturation. Our results therefore do not aim at formulating proper causal generalisations.

4 Empirical findings

4.1 De-hierarchisation and teamwork

An overall picture that emerges from the interviews is that the team leader's role and teamwork configuration vary considerably not only between firms, but also within the same plant. This

considered to be particularly advanced on a technological level. These companies, called 'focal firms', will give rise to case studies within the present research.

Firm	Department*	Task*
Cesab-Toyota	assembly line	vehicle assembly $(\times 2)$
	customisation	installation of cabin and optionals
		welding of cabin
	external logistics office	management of incoming supplies
	parts warehouse	assembly lines supplies
	quality control	intermediate vehicle quality control
Ducati	assembly line	engine assembly
		team leader
		vehicle assembly $(\times 4)$
	process designer	engine production designer
	product R&D	engine testing-room service
	quality control	process quality control
	testing	test drive
Lamborghini	assembly line	engine assembly
		vehicle assembly $(\times 2)$
	carbon fibre composites	carbon fibre lamination
		shell assembly
	pre-series center	carbon fibre process development
	process R&D	MES implementation
		human-machine interface development
	purchases department	parts purchases
	quality control	final quality control
	sales department	franchise and business development
	'task-force'	incoming supplies quality control
	torque team	control of electric screwer systems
	union representative	union representative

* At the time of the interview.

Table 2: Classification of interviewees by firm, department, and task.

is not only true regarding different configurations found between the production and planning departments, whose diversity may well be expected. Even restricting the analysis to the production area alone, we detect different configurations with respect to (i) the structure of teams, (ii) the practical involvement and responsibility of workers, and (iii) the role and functions of the team leaders.

4.1.1 Structure of the teams

With regard to the structure of the teams, the team leader is accompanied in some departments by a figure, called 'joker' (lit. 'jolly'), which has a substitutive function in case of absence of an operator, and a support function should an operator be in trouble with carrying out her task on time. Where this figure is in place, most likely within the production departments of Cesab-Toyota and less so at Lamborghini and Ducati, the team leader is relieved from the replacement function of workers and operational support to their tasks. Otherwise, it is a common practice that the team leader herself inherits the joker's replacement and support functions. In the latter case, although not formalised, this practice reveals a certain degree of discretion on behalf of the team leader. As it will be clear later on, this very discretion in enlarging the boundaries of her role and her functions constitutes one of the most critical traits of this figure.

> "The joker is one who masters several stages of production. [...] In terms of technical knowledge, the joker is less expert than the team leader. The joker is supposed to do what she's asked, but she's not required to know how to solve problems because her experience and knowledge is partial. She must act as a replacement, full stop. The team leader is the one who knows everything. [...] But the joker must be chosen on the basis of other criteria as well, not simply on her knowledge of the various phases. [...] She must know how to relate and work with others, be willingness and available, and if she sees someone in trouble, she has to come and help [...] [Some of the jokers] are [...] disagreeable, [...] others, [...] for instance the one who works on my segment, is an extraordinary person. She knows how to do things, she is capable, but above all she is available to help you. [...] She is an ideal joker. [...] Also because the willingness to help someone in trouble should be the criterion of choice for a joker. But sometimes I do not understand how they choose these people for this role. [...] Sometimes I ask myself: how did they choose them? [...] They should be available if they see someone in difficulty, but [some of them] don't care. [...] The selection criterion of the joker is, in my opinion, one of the flaws we have. That is, no criterion other than professionalism is considered. The criterion should be that the candidate knows how to 'gel' with the group, and her availability." (anon. from Cesab-Toyota)

Another variability encountered with the team structure is in the breadth of the team leader's domain, or the number of components that belong to the team. In this sense, the domains can vary considerably: from small domains consisting of a few employees (in some cases even 4-5) up to domains of about 20 employees. It seems the case that in those departments in which the production process is composite and diversified (e.g. inspection, testing, quality check...) the domain size is small, whereas in departments in which the process is routinised and fragmented (e.g. assembly lines) the domain is large.

In all this, the type of production technology itself also seems to play a role. For assembly lines the domain varies according to whether they are 'towed' or 'stop-and-go': in the first case the domain is larger, in the second it is smaller. Furthermore, in the segments of production featuring state-of-the-art robots and where the process of digitalisation is more advanced, the size of the domain tends to decrease (together with the total number of workers employed in these specific phases).

These aspects related to the size of the domain indeed deserve further investigation. However, it is possible to acknowledge that in no case the size of the domain and its variability have been discussed with workers. The dimensional characteristics of the domain and therein the number of team leaders to be appointed has been decided by managers and implemented without any workers' involvement (not even for advisory purposes). What is clear to the interviewees is that the issue of domain dimension hasn't been negotiated with union representatives either.

The size of the domain, however, does affect the relationship between team leaders and their subordinates, the role that the former is required to perform, and the type of practices of involvement and accountability of the operators.

4.1.2 Team meetings

Asaichis, classic devices of the 'Toyota way', are in place at Cesab-Toyota; at Ducati a number of periodic meetings are carried out among professionals of a production phase (defined as 'briefings' by respondents), and at Lamborghini such meetings take place regularly and are called 'teamwork'. Beyond the different definitions, in all cases these meetings are aimed, at least theoretically, at communicating programmes, socialising knowledge, investigating problems and possibly come up with collective solutions. Each of these devices, however, has different characteristics from department to department within the same establishment. For instance, the frequency with which the meetings take place varies: at Cesab-Toyota some respondents claim to attend the asaichi on a weekly basis, while other respondents, questioned about the frequency of asaichis, answer with a generic 'when it happens' (note that in this case it is almost a contradiction since the Japanese word asaichi literally translates to 'morning meetings', and a rigorous application of the Toyota way would require their daily scheduling). At Ducati, the frequency varies from weekly to monthly; likewise, at Lamborghini the frequency of meetings, which take place inside a room with transparent walls next to workstations, varies across departments. However, what seems to be even more variable is their function: despite all respondents consider these meetings to be useful for socializing knowledge, only in some cases they are considered real teamwork and decision-making practices that generate collective solutions to emerging problems. In several other situations meetings are considered simple collective communication devices, effective especially in reaching a large number of workers at a time.

> "In the warehouse we do [...] the asaichi on a weekly basis. [...] Meetings range between 15 and 30 minutes. [...] The 'chair' of the asaichi presents the problems without specifying names [...] then the quality responsible calls one by one to solve the specific issue. [...] The team leader sets up the meetings. We have this habit [...] of discussing over how things go, the communications the team leader herself receives. [...] We are quite up to date [...] and I feel I'm aware of what's going on."
>
> (anon. from Cesab-Toyota)

> "We do the teamwork every couple of weeks with the team leader and the head of department. This habit came with Audi; it wasn't there earlier. I find it right. If someone has to say something or has to raise some issues, it is important to discuss them."
>
> (anon. from Lamborghini)

4.1.3 Roles and functions of the team leader

Our interviews confirm that the introduction of the figure of the team leader represents an element of organisational innovation. The team leader performs functions that are not reducible to command-and-control leadership. Roles such as supporting/guiding the professional growth of workers (*coaching*), supervising the production process, and training and motivating the team, are aspects that respondents recognise as distinctive of the team leader figure compared to a traditional figure of line-, area- or department-manager.

In some cases the team leader also represents an important node of vertical (e.g. with the head of department) and horizontal (e.g. with other team leaders) coordination, acting as a communication intermediate.

The role of team leader, as many point out, is largely perceived as symbolic; it is a status-upgrade without a significant wage increase, not a formal upgrade within the organisational chart. It is therefore understandable that respondents recognise as particularly difficult the position in which the team leader sits. Pictures of 'stressed', 'multitasking', and 'always running' team leaders are recurrent in the interviews.

At the same time, a permanent unstable balance emerges between the formal and informal dimension in which the team leader role is positioned. Formally, the team leader is not required to

take responsibility for deciding how to deal with contingencies that arise during production, nor to take direct action to solve problems. In principle, her function should be limited to supporting and enhancing the problem solving skills of workers, leaving to these latter the decision on how to solve the underlying issue. However, it is normal practice that the team leader herself takes discretionary responsibility for the intervention, giving precise directions on how to solve the problem or intervening first person on the process to allow the workflow to continue.

> "The team leader is the figure that intervenes when we are in need. We have buttons [around our workstation.] [...] In case of need we press the button, a light blinks on the notice board at the top [of the line]. She sees it and intervenes. [...] For instance, in case we have problems with documentation, or with the cart that we can not inspect, [...] she arrives, you explain her what happened, and she decides what to do. She calls here and there, understands if it's something she can solve right away, otherwise she tells you to make a note on the log and send the cart forward. She'll take care of the problem and how to solve it." (anon. from Cesab-Toyota)

A team leader that we interviewed describes her working days as 'strongly multifunctional', and whose boundaries are discretionary. Such 'breach' of formal rules, understood as the availability of teaching how to deal with a technical glitch, taking direct action to solve a problem, helping those in need and/or replacing a worker in case of unforeseen or short absence from the station, is often appreciated by respondents. The discretion through which the team leader acts seems to allow workers to recognise her as depositary of technical and professional knowledge and socialiser of the latter through cooperative relationships with the team.

Technical and professional skills, while not considered the core of a team leader's competences, appears crucial for her recognition by the workers in terms of authority to exercise management and supervision functions. All this highlights a contradiction about perceptions of team leaders' selection criteria: on the one hand, it is argued that the expertise that the team leader must possess to effectively play its role consists of soft skills and management skills; on the other, it highlights the opportunity that team leaders are selected among the most technically competent operators, and stigmatises the figure of the team leader coming from outside the underlying unit or department, with little experience of that segment of the production process.

> "She's a very young person and has been with us for two months, she worked a bit both in our line and elsewhere. [...] When she came with us she had been coaching with our old team leader who moved to a new assembly line, [...] but now we are helping her too. On some technical things the team leader manages to interact with us [but] [...] there are other things that she just doesn't know. [...] In my opinion this is wrong... a team leader must have worked across the line, from the start to finish, and know it by heart." (anon. from Lamborghini)

Lamborghini has recently ruled that those eligible as team leaders must have the highest professional skills. These are symbolised by the presence of three black dots on the flexibility matrix for all the phases the team is supposed to carry out. Three black dots indicate that the person not only knows and is able to perform the task, but that she is also able to teach it. Once these skills are verified, in order to become team leader the candidate has to attend a training course focussed on the acquisition of interpersonal and managerial skills.

Certainly, the degree of discretion on behalf of team leaders vary from one another, even within the same plant, and consequently the coexistence of very different figures is possible. The discretionary action of team leaders is a reinforcing factor of the non-hierarchical nature of its role. The same discretion, however, is perceived by some respondents as a way through which, paradoxically, a re-hierarchisation of that role seems to pass. In several cases, in fact, the specific declination of the team leaders' discretion is accompanied by typically hierarchical functions. For instance, the team leader is the only member of a team in charge of implementing the involvement and empowerment practices of workers that have been described in the previous pages. Although the asaichi, the teamwork, and other continuous improvement processes (reviewed later in Section 4.2) are systems put in place by the management, their operational details are largely up to the team

leader's discretion, e.g. the frequency of meetings, the time spent collecting improvement proposals, etc... It is always the team leader who has the authority to stop the assembly line in case of a problem, and the operator only has to draw the team leader attention by pushing a button, connected to a visual or aural alarm. In fact it is rare, in a system where the *andon* is implemented, that the single operator has the right to stop the assembly line. It is usually a hierarchical superior (e.g. the head of department) who has the right to consider and, if deemed necessary, stop the line. In all our case studies, this authority belongs to the team leader.

> "The team leader has the authority to stop the line. [...] I report the problem, I press the button, the light comes on the screen, then the team leader arrives, she evaluates the problem and decides to stop the line if necessary. [...] But I do not [personally] stop anything. I cannot, it is her who decides." (anon. from Cesab-Toyota)

The overlap between the functions of the team leader and of the head of department (the latter being a typical hierarchical figure) is apparent when respondents discuss the evaluation of workers, which is also relevant for career upgrades, among the activities carried out by the team leader (more on this in Section 4.3).

All this confirms the vague and ambiguous nature of the team leader role. Her multi-functional character and her high degree of discretion are well recognised. Such discretion can be a reinforcing factor of a hierarchisation, or even a re-hierarchisation, process, with obvious consequences on the teamwork environment. After all, the term that many workers use to address the team leader is 'boss', and in the respondents' outline of organisational hierarchy she is almost always included as a hierarchical figure.

> "The team leader is your boss. Above her, sits the head of department. She is our reference. If you have to ask for the holidays you go to her, then she talks up to the head of department, but we go to her. [...] She is also a channel of communication. If you have a problem, you go to talk to her and she tries to solve it." (anon. from Cesab-Toyota)

4.2 Job rotation practices and participation schemes

The introduction of job rotation practices has the direct aim at ensuring a flexible production by means of maintaining a 'tense' production flow. In particular, it is reported that job rotation finds its fundamental purposes for the firm in terms of (i) gaining a time advantage with respect to the flow, (ii) intervening within the process in case interruptions occur, and (iii) allowing substitutions between workers in case of absence. More in detail, such substitutions take place not only at the level of task, but also between workers and machines.

> "Job rotation is useful for the question of keeping the flow continuously tense. Our department is two days ahead with respect to the assembly line. If you lose this advantage you risk screwing up everything, so you have to keep this advantage at all costs. If the robot breaks down we start welding everything by hand, but we must know how to do it, otherwise the line stops. [...] [If] the welding robot breaks down, we can fall back on our craftsmanship, but this craftsmanship must be cultivated."
> (anon. from Cesab-Toyota)

While the replacement of a defective robot turns out to be a peculiarity of the specific firm and stage of the process (e.g. in the welding department of Cesab-Toyota), the aim of allowing substitutions between workers in case of absences appears more widespread.

To most of the workers, the purpose of job rotation is quite clear. Although it is not explicitly known *who* does actually decide the specific rotation scheme, it is clear why this happens.

> "I do not know how it is decided who needs to know what, but I think the head of department and the eldest team leader make an agreement. They aim at making everyone learn about all the stations. The problem is that, unfortunately, there can be defections, and it is better if everyone knows how to do everything." (anon. from Lamborghini)

The perception of the operators is particularly interesting with respect to the possible contradiction between job rotation and a high degree of specialisation. However, the operators themselves recognise that it is the employer who benefits from the rotation between tasks, in so far as it allows an increase in coordination and in quality of both the process and the product. The degree of formalisation of job rotation practices is very different both between and within firms. Examples of a very formal and rigid structuring of rotation may well coexist with more discretionary and flexible instances, even within the same factory.

Although in all three case studies job rotation practices are widespread, in most cases rotation takes place between tasks/workstations rather than between departments. At Ducati, for instance, the difference between these two forms of rotation is also contractually recognised and distinguished as multi-purpose (i.e. being able to perform multiple tasks) *vs.* multi-functional (being able to operate on different stages of the production process).

> "Earlier, I spent ten years working in the assembly line. In nine years I have done several things: testing, quality control... I do not have multi-functionality, but I've been recognised as highly multi-purpose." (anon. from Ducati)

Along with the direct aim of increasing productivity, there are a number of indirect, or intermediate, goals, resulting from the adoption of job rotation. Among them, (i) the process of learning and increased knowledge on behalf of the operator about the production flow (employee learning), (ii) an improvement of working conditions thanks to a decrease of repetitive tasks (employee motivation), and (iii) the opportunity for the employer to monitor workers' performance, distinguishing the skills of the individual on the basis of the degree of multi-functionality in the process (employer learning). Some workers report themselves a high degree of participation in the production process, through the explicit willingness to learn those steps they have yet to know.

Along with the learning idea, workers benefit of being able to break the repetitiveness of their tasks. This aspect is certainly one of the key elements reported by respondents. In fact, repetitive tasks are poorly tolerated by operators, and cases of stress and fatigue are reported. In particular, the benefits of job rotation relative to the reduction of physical and psychological strain are the most appreciated.

> "It has been three months now that I am stationed at the same point of the assembly line and it is driving me a little crazy." (anon. from Ducati)

In terms of efficiency of the production process, it emerges in a non-obvious way how the continuous performing of the same tasks not only demotivates the operator, but also increases the probability of making mistakes.

> "I'd like to change my task due to monotony, because repeating the same thing for ten months in a row makes you lose the stimulus, and you are more prone to those mistakes that if you change a little more often occur less." (anon. from Cesab-Toyota)

Finally, job rotation and the degree of tasks flexibility may constitute key criteria for the evaluation of the individual worker. In fact, while at Ducati versatility and multi-functionality are contractually recognised, at Lamborghini it is rather the flexibility matrix that is used for the evaluation. For instance, this matrix appears to be a crucial driver in choosing those workers to relocate to a brand new assembly line. In this regard, the introduction of the new Urus SUV at Lamborghini has seen the displacement of a number of workers towards the new line. One respondent reports that workers with a permanent job, that incidentally have acquired better expertise and knowledge of the production process and therefore display a greater added value, are more likely to be transferred to the new line, while temporary workers are placed along older lines. However, at the current stage, is not yet entirely clear to respondents how such transfers from the old to the new line will actually take place.

From these excerpts it emerges that there is no co-managed process in the selection of workers to be transferred to the new line; rather, this decision appears uniquely up to the human resources department. Some respondents at Lamborghini fear that this approach could also result in short-sighted choices.

Therein, an additional level of contradiction emerges with respect to the implementation of job rotation and workers participation practices. These schemes appear successful in increasing the knowledge of the worker, and 'breaking the routine'; however, the degree of participation in decision-making concerning the extent and mode of rotation of workers is perceived as very limited. This leads to potential tensions between management and workers. It seems that the workers themselves may possess greater awareness of who might be better suited to step on the new line, rather than a top-down decision of the human resources department. Although the relationship between knowledge and decision-making power is not fully addressed in the body of the interviews, there is evidence of tension between bottom-up knowledge creation and top-down decision making.

After distinguishing between direct and indirect objectives related to job rotation, it is relevant to understand the coexistence of job rotation practices with other HPWPs, in particular the presence of teamwork and other participation schemes aimed at increasing the workers' involvement through the collection of suggestions for improvements and/or resolution of errors. In our case studies we have found similar but differently labelled continuous improvement processes, namely kaizen at Cesab-Toyota, GMK at Ducati, and 'management of ideas' at Lamborghini. Focussing on the effects of such practices, both on the potential improvement of the production process efficiency and how they impact the authority of intervention of workers with respect to the firm's objectives, it emerges a kind of awareness regarding the benefits accruing to the firm coming from teamwork.

> "We work a lot together, we work a lot as a team but it is obvious that everyone has their own role. It's a planned thing, done by the coordinators who design this programme for everyone. They want each of us to be able to do the work of others, and there are organised learning paths for us to do so." (anon. from Cesab-Toyota)

However it is also clear that respondents feel a sharp perception of hierarchy, and ensuing fear/reverence with respect to their boss. The flow of information and decisions, although it is formally structured according to a horizontal hierarchy (the team), turns out to be considerably imbued with vertical hierarchy, both in terms of knowledge, from the head to subordinates, and during the evaluation of proposals, which always passes through a higher figure in the hierarchy.

> "We have the 'management of ideas': working on a station I notice a defect, I ask the team leader to bring me the paper for the management of ideas, I write the improvement and I deliver it to the head of department. The latter will deliver it to the heads of the other entities who assess the idea and there is also an economic compensation if there is an actual improvement e.g. about safety issues." (anon. from Lamborghini)

Even in those cases in which the practice of job rotation is quite structured, the proposals resulting from the suggestions of workers, namely the bottom-up implementation of a systematic process of collecting knowledge, are largely unfilled.

> "I had brainstorming experiences during the GMK period. In general, however, one speaks with the supervisor. Thanks to GMK we have put a box next to the line where an operator can make an improvement request. I do it mostly by habit, but I notice that most of the time suggestions are not considered. It is difficult to translate the idea into a practical plan of action." (anon. from Ducati)

Although systems for proposing potential improvements are in place (ranging from the kaizen to the 'management of ideas' or GMK), there appears to be a lack of systematic collection and consideration of such proposals. In addition, there is no explicit notification when a certain proposal is under review. Both the collection and the assessment still appear to be carried out in a discretionary fashion.

> "Are reports of improvements accepted? If the head of department is in a good mood she will listen to you. Sometimes the supervisors do; it depends on who is in front of you. It happened to me, now that we are doing GMK. There they listen to you and if you have some ideas they want to put them into action." (anon. from Ducati)

Finally, the modes proposals forwarding and rewarding systems are not always perceived as boosting the cohesion of the team. Although it is possible for workers to forward suggestions for improvement as a group, the proposals are usually made individually and the prizes for the best proposals, either monetary or fringe benefits, are awarded to single individuals. According to some respondents, this reward system strengthens cooperative relationships between workers and the company, but also feeds the establishment of competitive dynamics between workers, and not coincidentally a widespread feeling of competitiveness is recognised. Such practices do not seem to favour the socialisation of knowledge, for example about a problem and its solutions, with colleagues.

4.3 Performance evaluation systems, mobility, and career prospects

The analysis of the interviews reveals the existence of a certain degree of heterogeneity in the perception of evaluation systems, especially regarding the discretion and uncertainty in the assignment of prizes, and clarity about the assessment criteria. A lesser degree of heterogeneity emerges in the perception over who is actually in charge of the evaluation process. The respondents highlight the existence of a certain amount of discretion in the allocation of monetary prizes (e.g. the zero-error award) and non-monetary incentives (e.g. contractual level upgrade, promotions, etc...). Therefore, the performance evaluation system is perceived as discretionary, and in some cases even unfair, especially regarding non-monetary incentives and career prospects.

> "I've won a zero-error prize [...] this also at the discretion of the boss every three or four months. My supervisor came and told me 'go see the head' and the latter told me 'look, in this period here you worked very well; if you want I can award you a prize', with a procedure that is a bit embarrassing." (anon. from Ducati)

Sometimes, the non-allocation of these incentives can fulfil a disciplinary function of individual behaviour within the workplace.

> "The level upgrade is sometimes given as a prize, sometimes to those who are more motivated on the job, sometimes to others [...] Working extra hours, always being available, always saying yes... There are people like this and others who set more boundaries. The latter are less likely to get a level upgrade." (anon. from Cesab-Toyota)

The perception of discretion in the award of monetary prizes is attributable, among others, to the age and seniority of the worker. Younger respondents report the existence of a common practice by which prizes and incentives are generally awarded taking into consideration the experience of the worker and the overall time that she spent at the company.

Some workers recognise the existence of a formalised system of evaluation and, therefore, perceive a lower level of discretion in the allocation of rewards and level upgrades. However, despite the introduction of a formalised 'report card' (only at Lamborghini) containing an assessment of the performance of the worker, some respondents perceive a margin of discretion in passing from a positive evaluation to the ensuing economic reward.

> "There are people who have all three dots for all the tasks. But from an economic standpoint there is no difference compared to others. I do not think there are advantages, even in terms of status." (anon. from Lamborghini)

Among the monetary incentives, bonuses may apply. Again, however, some workers report confusion and lack of clarity regarding the adopted criteria for the allocation of bonuses.

Even the existence of a more formalised system of employee evaluation does not rule out that some workers express unawareness of the use of the report card (an evaluation spreadsheet).

> "I do not think that report cards are used to fine tune the remuneration. I understand the concept of the report card as in school, in the sense that if you're good you get a good grade, but I do not know then where this report actually ends up."
> (anon. from Lamborghini)

Closely intertwined with the perception of greater or lesser discretion in the award of prizes, is the clarity about the evaluation criteria. At Lamborghini, this system turns out to be quite clear and formalised. As noted above, at Lamborghini, a system of workers' co-participation in the drafting of goals against which to calibrate the evaluation criteria is in place.

> "There are annual evaluations in which they assess professional objectives related to what you do, company objectives linked to the firm, and individual objectives, e.g. learning German. The goals are decided together." (anon. from Lamborghini)

The existence of some forms of evaluation of performance in qualitative terms is sometimes perceived as beneficial in order to improve the work practice.

The influential figures on the evaluation of performance also deserve some reflection. In all three cases studies, it is the head of department that plays an important role in the assessment of workers, although the team leader retains some degree of influence. Where the evaluation process is perceived as more standardised, there is also greater clarity on who are its influential figures.

> "It is the head of department who has the last word. Perhaps the supervisor can notify that a person is working well. The head of department knows us personally, also because mine has been here for 15-20 years." (anon. from Ducati)

The team leader also serves as an intermediary between the operator and the head of department for the provision of incentives.

> "The team leader can have a say in giving you a higher [contractual] level. She makes her own assessments about you and advises the head of department, who in the end is the one who decides. But the team leader has a say because she is the one who keeps her finger on the pulse of the situation, she sees us there every day and knows us. In short, the team leader has influence, and even to a good extent, although the final decision is on behalf of the head of department." (anon. from Cesab-Toyota)

There is a certain degree of variability between different departments. For instance, white collar workers do not have a team leader and their evaluation is carried out by their coordinator. The assessment mechanism is sometimes supported by regular audits entrusted to external firms. Such a procedure is not perceived as intrusive by respondents.

In all the three case studies, an operator's versatility and multi-functionality are encouraged and recognised characteristics. However there is a perception of arbitrariness and sometimes of injustice concerning their formal recognition.

> "The recognition of being multi-purpose works that, the more things you know... For example, this year I got the basic level. Maybe I should be granted the higher one since I know how to run the trial stage; maybe I should have that medium one at least. Regarding levels I do not know [...] Recently, a person who knows how to do everything was recognised medium multi-purpose when she would deserve the high level. [...] In the end it is not so much for the remuneration premium, it is more a matter of personal recognition, the economic side is almost irrelevant." (anon. from Ducati)

A different reasoning goes with mobility programmes, which in many cases are managed as an extension or replacement of monetary incentives, put in place to motivate the employees in relation to their work and encourage a sense of 'membership' and attachment to the firm. Different respondents provide different perceptions even within the same firm. Some workers, mainly assigned to assembly tasks, highlight the existence of mobility criteria that are not clear, nor formalised. While the possibility of 'getting ahead' is widely recognised, the contractual level upgrade is subordinated to the assessment contained in the report card (at Lamborghini) or to the judgement and discretion of the boss.

> "Career advancement is not clear, as is not the reason why one person is chosen over another." (anon. from Ducati)

What is especially perceived as relevant for career prospects is the ability to stand in terms of social aptitude, and anything that can be traced to soft skills. The same perception applies to the assignment of the role of team leader. In some cases, it appears that the choice of appointing one has been arbitrarily dictated by non-professional factors.

> "Who becomes a team leader here? Those who do more overtime and those who have no children! Of course, afterwards she receives training and becomes a truly competent figure, but the selection is... on the basis of sympathy so to speak... we cannot hide it." (anon. from Cesab-Toyota)

Some responders emphasise the presence of limited vertical mobility, hardly formalised, and more often than not individually negotiated. At Ducati, the upgrade from 4th to 5th contractual level is widely perceived as distant, remote, implausible. Feelings of immobility in career terms negatively affect what may be otherwise called a general job satisfaction. As for the incentives and monetary rewards, level upgrades are perceived in some cases as discretionary. The paths of vertical mobility are seen as rare and difficult. Sometimes, this immobility is linked to gender issues, turning into a complaint of unequal treatment between men and women with respect to career prospects and work/life time reconciliation.

> "As a woman I think I have limited career prospects. I do not see big career opportunities inside my office. We have a boss, a German coordinator who will return to Germany. We are all more or less on the same level. The maximum I can aspire to in my office is being a coordinator. Instead, if they move you to other departments they can give you salary increases and responsibilities." (anon. from Lamborghini)

The passage from blue-collar to white-collar jobs within the same firm, although not exceptional, are perceived as such. The recent introduction of more stringent requirements for access to white-collar jobs in terms of formal qualifications is sensed as a barrier for such transition. White-collar respondents report the desire on behalf of the management of more frequent vertical mobility from the assembly line to the office, although their perception parallels that of their blue-collar counterparts.

> "Those who are hired nowadays as white-collars are all engineers, but many employees who have been here for some time have moved there from manufacturing. [...] Once it was easier. [...] I was a joker, I could do pretty much everything. Now there is the assembly line, but once it was different: we used to build the product from the beginning to the end. [...] You could see who was good; now you see less your ability. Then I finished university, [...] they saw me, and moved me to the office."
> (anon. from Cesab-Toyota)

5 Interpretation of empirical results

From our case studies it emerges that the introduction of I4.0 technologies has been accompanied by the effective implementation of organisational changes aimed at increasing workers' involvement and responsibilities. All this, however, seems to have occurred through forms and processes of hybridisation between formalisation and arbitrariness. This hybridisation does not occur simply in a comparison between firms, but also in the coexistence of the organisational levers within the same organisation, and in particular in an evident tension between the implementation of HPWPs aimed at extracting value/knowledge from workers on the one hand, and those aimed at redistributing value to workers, on the other.

The notion of arbitrariness is particularly relevant with respect to the absence of formal mechanisms regarding career advancement and the awarding of individual prizes: in this sense, workers perceive as arbitrary the identification of those who 'deserve' a contractual level upgrade, what are the parameters of this evaluation (e.g. performance, dedication...), and what are the timing of such advancements. Although the degree of such formalisation varies across firms, even at Lamborghini, which implements clear flexibility matrices, workers struggle to understand the purpose

of 'report cards'. Moreover, unlike HPWPs, career advancements and prizes are more related to disciplining, rather than motivational goals. In what can be seen as a blurred dichotomy between the ensemble of those practices that are intended to extract value from workers, in the form of productivity increases, substitutability between tasks, streamlining of downtime, greater coordination (job rotation, participation, teamwork), and those intended to redistribute value to workers, such as level upgrades and monetary prizes, it should be noted that this tension is present in all our case studies.

It can be argued, as recognised by workers themselves, that the introduction of I4.0 technology has been accompanied by organisational changes that favoured a broader diffusion of knowledge of the production process. The introduction of new technological artefacts and processes are often preceded by moments of information and communication through team meetings (and in some cases even by moments of proper training). These meetings (e.g. asaichis) also serve as communication channels for the socialisation of knowledge, e.g. regarding issues and contingencies that occur along the assembly line. Alongside, continuous improvement processes have been implemented, requiring the active participation of workers. Job rotation fulfils the dual function of extraction/restitution of value and knowledge to/from the workers, and in fact contributes to increasing the spectrum of tasks that operators can perform; these multi-functional aspects are also taken into account, and certainly encouraged, by systems of evaluation and career progression in all three case studies.

A first result of our field research is that the introduction of I4.0 technological artefacts, along with the implementation of the three organisational levers taken into account in the previous sections, appears to have produced an increase in the authority to intervene in the work process in terms of discretion. Such discretion is in many cases required or at least favoured by the organisational practices in place. Many respondents, in this regard, have confirmed that the newly introduced technologies require an organisation of work that entitles the operator to decide how to reach a specific goal. However, while there is a general increase in the intervention authority in terms of discretion, many respondents have revealed important differences, not only between different firms, but also between different departments of the same factory. In this sense, it is not possible to ignore the case of Cesab-Toyota, in which the increase of discretion, formally encouraged by the firm itself, collides with the strong reduction of the takt time, in line with the Toyota way inspiration. From the interviews with workers therein, a friction emerges between the encouragement of proactivity and variability of tasks, and the limited time available for carrying them out. This conflict is attenuated at Ducati and is hardly present at Lamborghini. Arguably, the specific product that is manufactured in the three firms might well play a role in the explanation of the differences found. The forklifts manufactured at Cesab-Toyota cannot be considered mass consumer products, and their customisation has grown considerably over time; still, they are serially produced in large quantities, especially compared with other actors in the industry. Despite the possibility of customising some details on certain products, also the production of Ducati stands at high volumes (grown considerably in recent years), but compared to other competitors in the industry (such as Honda and Kawasaki) it ranks comparatively low. Finally, Lamborghini luxury cars represent a typical example of a niche product (also in this case, however, there has been an increase in production volumes, and these are expected to grow at a faster pace in the future, after the launch of the new Urus SUV).

Along with these differences in the authority of intervention in the work processes detected across firms, a few situations appear to differ within the same factory. In other words, in some departments the consequences of the introduction of I4.0 technologies appear dampened, and in some cases workers intervention is even reduced, opening up to processes of *deskilling*. An extreme but emblematic example is the adoption of digital torque wrenches on assembly lines (within all three studied factories). The digitalisation of torque wrenches allows the collection, storage, and analysis (through dedicated wireless networks) of high-precise data about how a specific bolt has been tightened. However, such digitalisation appears to be used instead to stiffen the procedure of the various tasks. The data can be processed in real time and monitored remotely from a supervisor; the operator using the torque wrench can see on a screen the result of her work; should the bolt be not correctly tightened, the screen would display a red light indicating that the operation has to be repeated; if the error doesn't get corrected (the bolt is not unscrewed and screwed back

again) the light doesn't turn green (the signal indicating that the operation has been carried out correctly) and the computer doesn't unlock the tool to perform the next task, thereby enforcing a rigid sequence along which the operator must perform the various operations.

As a second result of our field research, organisational changes that have accompanied the introduction of I4.0 technology have generally produced an increase of workers' authority of intervention in the work process in terms of discretion. However, this increase is significantly different not only between firms, but also among different departments of the same factory.

The analytical distinction between discretion and autonomy in our theoretical framework also made it possible to detect another very important aspect, namely that the general (although non-homogeneous) increase in discretion on behalf of respondents do not seem to match a likewise increase in the autonomy of regulating the work process. The possibility of being involved in the design of the very organisational practices expected to foster autonomy on behalf of the workers is also perceived as limited. For instance, it emerges that while teamwork and job rotation constitute practices aimed at increasing the knowledge of workers about the production process, such an increase in knowledge in many cases results in an expansion of *ex-ante*, pre-defined actions.

Therefore, if an increase of autonomy in decision-making appears to be characterised by the ability to assert an own set of rules, our results picture a framework in which the autonomy of workers appears quite limited, and upon which the introduced organisational practices do not seem to have exerted a significant impact. The case of Cesab-Toyota is emblematic in the sense that, although the andon is present, the individual worker has no decision authority to stop the assembly line, and instead this formal decision is always up to the team leader. In case such decision is made jointly by the team leader and an operator, it is the team leader who deliberately (partially) gives up its formal authority. Likewise, support mechanisms for continuous improvement and evaluation systems do not seem to significantly improve the autonomy of workers. Despite these systems are more or less effective in engaging, empowering, and motivating workers, it rarely emerges from the interviews the ability to decide the timing and modes of operation of these systems. Similarly, during the introduction of a new assembly line at Lamborghini, the choice of which workers should be relocated turns out to be entirely on behalf of the management; or at most by individual candidates, but not through the involvement of teamwork.

Therefore, a third result of our field research is that the organisational changes that have accompanied the introduction of I4.0 technology in general did not create the conditions for an increase in the autonomy of workers, especially in terms of the increased ability of establishing their own rules in the organisational and production process.

6 Conclusions

On the basis of what has emerged from this research and without aiming at generalising our results, we argue that the implementation of organisational changes accompanying the introduction of I4.0 technology do not necessarily result in a uniform increase in the discretion of the operators, and especially do not necessarily lead to an increase in their autonomy.

It is possible to inquire, again on a theoretical level, whether the results that this research highlights actually reflect a specific 'lean philosophy' or rather represent an intentionally designed organisational model. We believe that the answer to this question should be sought in the theoretical-epistemological perspective through which one interprets the results. Within a theoretical perspective of institutionalist character, which contemplates a possible dialectic coexistence of multiple organisational logics, the hybridisation of arbitrariness/formalisation through which the new organisational practices have been implemented can be attributed to a conflict between different organisational cultures exerting pressure on change. In an analogous fashion, the absence of a parallel increase in discretion *and* autonomy might be interpreted as a by-product of the conflict between different cultures, while none of them is able to penetrate completely. And if it is assumed at the same time that one of these logic is a clear winner, in terms of adequate exploitation (not necessarily in efficiency terms) of I4.0 technology potential, it is easy to fall to the idea of 'non-completed implementation stage' or rather 'cultural conservativeness of the management'. If, instead, our results are deciphered within a theoretical-epistemological perspective in which the organisational rationality, albeit limited, assumes a greater weight, then the conclusions change significantly. In

this case, the selective adoption of practices which are institutionally prescribed by an organisational paradigm (lean production aimed at I4.0) can result from a misalignment or discrepancy between aspirations and performance, whose relationship is subject to a process of continuous adjustment. However, the process of creation of these aspirations is very inertial (Winter, 2000). Changes in aspirations are in fact influenced by both the cognitive framework and the experience accumulated in the execution of practices already in place, and therefore the cost of adopting new practices related to the emergence of new aspirations is high. This results into stable organisational routines. The ability of transforming and innovating the existing organisational routines derives from the development of *dynamic capabilities* (Gavetti, 2005) which ultimately allow the adoption of change. In this respect, it is therefore possible to interpret the identified hybridism as, paraphrasing Vidal (2017), 'lean enough'. The set of adopted practices are attributed to those at the basis of the lean philosophy, which is, however, designed as a 'toolbox' from which to draw in order to meet a predetermined target, albeit temporarily. Similarly, the misalignment between autonomy, virtually unaltered, and increasing discretion is not attributable to a delay or an irrational deviation, but rather as a goal that is deliberately pursued. It is clear that research trajectories that can be identified from the present findings may well change direction, depending on the specific adopted perspective.

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