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► **To cite this version:**

Alexandra Lagorio, Chiara Cimini, Paolo Gaiardelli. Reshaping the Concepts of Job Enrichment and Job Enlargement: The Impacts of Lean and Industry 4.0. IFIP International Conference on Advances in Production Management Systems (APMS), Sep 2021, Nantes, France. pp.721-729, 10.1007/978-3-030-85874-2_79 . hal-04030413

HAL Id: hal-04030413

<https://inria.hal.science/hal-04030413v1>

Submitted on 16 Mar 2023

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Reshaping the concepts of Job Enrichment and Job Enlargement: the impacts of Lean and Industry 4.0

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Abstract. The latest innovations in the manufacturing technologies significantly affected the roles of workers, both concerning task variety and required skills. Consequently, in a highly digitalised context, operators and managers are facing increasingly job enlargement and job enrichment requirements in order to perform new and different activities and functions. This paper aims at exploring how the concepts of job enrichment and job enlargement have been evolving over time, through a systematic review of the literature. From the analysis, it emerged that the concepts have been enriched with broader meanings according to the two different production paradigms, in particular with the introduction of Lean Manufacturing principles up to the introduction of the Industry 4.0. The study highlights that if the lean principles strongly promoted the idea of enlarging and enriching the workers' activities to promote their involvement and motivation, supporting leadership attitude and soft skills, additionally the Industry 4.0 significantly affected an enlargement of tasks in space and time, requiring enriched technical skills to manage complex digitized processes.

Keywords: Job Enrichment, Job Enlargement, Lean manufacturing, Industry 4.0

1 Introduction

The shift from traditional industry to the so-called Industry 4.0 paradigm has been radically changing the way many industries approach their manufacturing operations [1]. In particular, the advent of new technologies able to assist, support, and in some cases even replace operators and managers in the execution of their daily tasks [2, 3], calls for the necessity to investigate job characteristics and skills required in work environments that are faster and more innovative than before [4]. Indeed, while the introduction of new technologies makes the work of operators and managers easier and often less routine and dangerous, digitalisation of activities increases their complexity. Therefore, having operators with a higher degree of technical and methodological skills becomes an essential requirement to avoid the creation of new forms of waste [5].

It has also been observed that increasing the degree of automation of certain tasks or supporting the operator in their execution often reduces both the time and physical efforts. This leads to a rethinking of the role of the operator, who is no longer seen as a simple performer of a task, but rather a resource capable of 'managing' the single

activity to be performed, including, for example the collection and analysis of data related to the activity [6]. This increase in responsibility and extension of the activities performed by the operator opens in turn a debate on the necessary technical-cognitive and managerial-decisional skills, and on the evolution of job profiles [7]. The operator goes from being a simple executor to the manager of an activity and at the same time there are new profiles required (e.g., data analyst, etc.). All this means that in a highly digitised Industry 4.0 context, operators and managers must increasingly enlarge and enrich their skills with new competencies to perform different activities and functions. This is certainly not a new perspective and in any case already investigated by the scientific literature long before the advent of the 4.0 paradigm; however, the concepts of job enrichment and job enlargement have been enriched with broader meanings over time according to the different production paradigms.

In this regard, the aim of this research work is to explore how definitions of these two terms have changed in the years and it has the result of highlighting how the two main production paradigm that have profoundly change the manufacturing context (i.e., the lean and the industry 4.0 paradigms) affected the nature of the concepts. The research is organized as follows: the study moved from the evidence that the latest innovations in automation and digitalisation, pushed by the Industry 4.0 wave are changing the workforce tasks and skills (Section 2). Therefore, the concepts of job enrichment and job enlargement have been researched through a systematic literature review, illustrated in Section 3. The insights emerging from it enabled to recognise an evolution of the two concepts, which is discussed extensively in Section 4. Finally, conclusions and further research directions on the topic are drawn in Section 5.

2 The impacts of Industry 4.0 on the workforce

The Industry 4.0 wave is pushing the transformation of traditional manufacturing systems into smart manufacturing systems, thanks to the combination of communication, IT, data, and physical components. The strong techno-centric approach that have characterised the research about Industry 4.0 in the first years, is now becoming surpassed by the new concept of human-centred smart manufacturing systems [8], recognising that human-technology integration will be crucial in the future of manufacturing.

Indeed, the development of Industry 4.0 will be accompanied by changing tasks and demands for the humans in the factory. In the light of strong automation and digitalisation, workers are seen as the most flexible entity in the future cyber-physical production systems: generally, it is expected that the easier and most repetitive tasks will be fully performed by autonomous robots and intelligent machines, leaving the operators more difficult and various jobs [9].

The projections about the impacts of Industry 4.0 technologies on the labour market and work organization have been already discussed in literature [7, 10] while a growing debate about the future of traditional job profiles have started with the work of Frey and Osborne [11] and is still running.

By the way, the view of technology as only a way to replace operators in the most physically demanding activities is limited, since the scope of the technologies introduction should be to support at large the workers in performing their job more

efficiently and effectively. According to [12], Industry 4.0 can empower the workers based on adapting the factory shop floor to their specific skills, capabilities and needs, and can further support the worker to understand and to develop his/her competence. Further, a continuous observation of the interaction of the workers with the production systems can enable the implementation of adaptive mechanisms in the workstations in order to improve the operator safety, satisfaction and well-being as well as the factory's production measures [13].

In this sense, many digital technologies, such as integrated information systems and data analysis-based decision support systems can play a relevant role in enhancing the cognitive activities of workers, not only at the middle management level, but also for *blue collars* job roles. In fact, a new job profile has been depicted, i.e., the Autonomous Operative Job Profile, in order to explain how the degree of autonomy and the number of different tasks are increasing, requiring workers to have a higher level of independence and proactivity in performing their job [6]. Moreover, others suggest that the introduction of Industry 4.0 technologies and tools has produced a general increase in workers' intervention authority on the work process in terms of decision making, and therefore augmenting the variability and intensity of task execution [14].

Therefore, it emerges that typical Industry 4.0 employees will get used to being more autonomous than in the past, working in a team, covering different roles and with a problem-solving approach, rather than limiting themselves to execute supervisors' and managers' instructions, expecting new meanings in the job enlargement and job enrichment perspectives that employees 4.0 need to acquire.

3 Methodology

In order to take into account the development of job enlargement and job enrichment concepts, as well as to capture their distinctive characteristics into a new synthetic definition, the systematic literature review was identified as the most suitable methodology to adopt, being considered the best efficient and replicable way to quickly identify what has been produced on a distinctive topic.

To develop the systematic literature review, we adopted the procedure followed by [15] based on three steps: i) the definition of the inclusion and exclusion criteria; ii) the selection by titles and abstracts; iii) the selection based on the whole reading of the papers with the application of the snowballing technique. These are briefly described in the following.

3.1 Step 1: Inclusion/exclusion criteria

The first step in carrying out a systematic literature review is the identification of the keywords. First, a preliminary list of the keywords and inclusion criteria were identified considering the concept of job enrichment and job enlargement by various synonyms (e.g. polyvalence, multi-skilling, polycompetence), to make our research as comprehensive as possible [16]. Further a first run of exploration we decided to use only the terms job enrichment, job enlargement and multi-skilling referred to the manufacturing context, to limit the research only to the most fitting cases for our research goals, and avoid any misleading. Since we wanted to observe the evolution of

job enrichment and job enlargement concepts over time, we decided not to set any time limit for the start of our research. The research was limited to peer-reviewed papers to gain consistency between themes and sources and to ensure the quality of the selected papers [17]. A first search attempt was launched. Following this, a double-blind control test was performed [18] on 10 papers to verify and refine the selection criteria. More specifically, each author carried out a manual selection of the articles to verify their coherency with the inclusion and exclusion criteria. Every paper that met with disagreement regarding inclusion/exclusion criteria was read and discussed until agreement was reached. This led to the definition of the final selection criteria as reported in Table 1. The query was then launched again, which resulted in the extraction of 58 papers.

Table 1. Inclusion criteria

Inclusion Criteria	Description
Keywords	job enlargement*, job enrichment*, multi-skilling* AND manufactur*
Language	English
Document types	Articles
Source types	Peer-reviewed journals
Time Interval	Until 2021

3.2 Step 2: Selection based on title and abstract

Each author reviewed the titles and abstracts of the selected papers. Following a discussion among the authors, papers out of the research scope were removed from the corpus. In particular, 19 papers that did not focus strictly on job enlargement and job enrichment were excluded from the analysis.

3.3 Step 3: Selection based on full text and snowballing

The last step of the protocol involved the refining of the list of selected papers. After reading the full versions of candidate papers, 21 papers were considered out of scope since they did not provide any definitions of job enlargement or enrichment. At this point, a corpus of 18 papers was analysed. Then, a forward and backward snowballing process was conducted. We adopted backward snowballing to exploit the reference list to identify potential new papers to be included. We read titles, abstracts and full papers if necessary and then we decided whether to include them in the final sample. Forward snowballing was carried out to identify new papers to include starting from the analysis of papers citing the ones contained in the first list of 21 papers. The approach to going through the papers was similar to in the backward method [19]. The two procedures were iterated until no new papers were found. This activity added 6 new papers to the corpus, leading to a final set of 24 papers.

4 Job Enlargement and Job Enrichment concepts' evolution

Due to the space constraints, the complete list of the systematic literature review results is provided at the following link:

<https://docs.google.com/spreadsheets/d/1WshGOZOXQV9-oWxBjWuNyD1zSfVNZ8ce4wFc2nXSmCs/edit?usp=sharing>.

Combining the papers reported in the attached link with other interesting academic articles, excluded from the final list because they did not contain explicit definitions of job enrichment and job enlargement, but whose reading proved useful to better understand the evolution of the subject, three different evolutions of the two phenomena emerged from the SLR results. Indeed, these three different evolutions refer to three historical moments delimited by two important changes in the history organisation of work in manufacturing: the introduction of the lean philosophy and the development of the Industry 4.0 paradigm. In particular, we noticed how the meaning of job enrichment and job enlargement has changed their nuance between before and after the introduction of the lean philosophy and before and after the introduction of the Industry 4.0 paradigm. In the following sub-section, we will describe more in-depth the evolution of the job enlargement (4.1) and job enrichment (4.2) concepts.

4.1 Job enlargement concept evolution

The term job enlargement essentially refers to the possibility of expanding an operator's tasks or duties [20]. Observing the definition provided in the 60s and 70s, the concept of job enlargement was initially considered as an advantageous condition for companies by favouring greater flexibility in a horizontal sense [21]. However, with the advent of lean thinking principles in Western countries, the term began to take on a broader and deeper meaning and more close to the social perspective. In particular, the advantage of managing work in a more complete way, avoiding fragmentation and consequently loss of productive efficiency and quality, was accompanied by the idea that the enlargement of tasks favours greater skill variety and identity. Providing "a sense of completeness and increasing the meaningfulness of a job" [22], job enlargement drives operational efficiency in the long term [23] through improving workers' satisfaction and motivation. A perspective, the latter, that perfectly fits with the basic principle of lean thinking according to which Monozukuri, the art of doing things (well) that characterizes any lean process, can only be achieved through Hitozukuri, the art of doing people (well) [24]. This means that only through a continuous training of personnel is it possible to pursue production efficiency goals [25] and that, conversely, underutilizing people's skills or not contributing to their growth not only is disrespectful, but also a waste.

For this reason, several authors underline the importance of the training aspects in the job enlargement definition as well [26, 27]. The importance of developing multi-skilled polyvalent Shojinka workforce is stated also by [28]. With the advent of the Fourth Industrial Revolution after 2010, the concept of job enlargement is further extended. While all the considerations that emerged with the advent of Lean principles remain valid, Industry 4.0 is pushing towards ever greater automation of certain tasks (especially the most repetitive or dangerous ones). The operator thus finds himself moving from performing single operational tasks to performing several tasks in parallel

to control and supervise multiple machines and equipment. Besides this enlargement of the tasks in the working space, Industry 4.0 technologies also involve an enlargement of activities in time, since continuous monitoring of the manufacturing processes is enabled, thus supporting a non-stopping control over the production, compared with the previously adopted discrete control of both production and product quality.

4.2 Job enrichment concept evolution

In a similar way, according to the first definitions provided in the literature, job enrichment was initially seen only as a tool to give more responsibility and autonomy to workers [29], making them more involved in decision-making in order to increase their satisfaction [30]. While job enlargement was seen as a way to enhance horizontal increase in the number of activities to be performed, job enrichment was interpreted as a source of vertical increase in one's own activities [19]: the more an operator understands the production process in which he is working, the more he is able to make decisions and intervene autonomously if problems arise. Horizontal and vertical sense of a job refers to a T-shaped competence model, in which workers have a combination of both general skills across multiple domains and specialist skills within (at least) one domain [31].

With the advent of lean thinking, two main concepts emerge. First, the enrichment in the process knowledge is promoted, with the involvement of the worker not only in the production activities but also in supporting the setup and maintenance phases. Second, a special attention to the soft skills emerges, taking the concept of T-shaped competence to the extreme and going beyond the mere perspective of integration of technical expertise and process orientation. Indeed, the concept of job enrichment is not only limited to participation in decision-making or increased responsibility but also extends to proactive, problem solving and leadership skills [32, 33]. The expertise and experience further enrich the roles of workers to the point of investing them with the role of teachers towards their own colleagues, promoting the concepts of sensei. Here again we observe that the worker, by increasing the knowledge of the process in which activities and tasks are embedded, becomes more and more expert, continuing to learn new aspects of work and being able to produce continuous feedback [34] that can become a good basis for introducing innovations [35].

The ability to provide continuous feedback and proposals for improvement is enhanced by the digitalisation that is at the heart of Industry 4.0. In fact, real-time data collection from the shop floor and wide connectivity of the equipment enable the possibility reproducing digital twins of the production processes to run analysis and simulations. In this context, the operator no longer only needs to know his business and the process in which he/she is involved, but must also be able to identify, analyse and interpret the data that are continuously provided by the machines, in order to report any anomalies or corrections that could increase the efficiency of the entire production. Consequently, the responsibility of employees is increased by adding more administrative and qualified tasks, along with increased employee involvement [5]. For this reason, while lean principles fundamentally promoted the development of workers' soft skills, such as leaderships and problem-solving, the Industry 4.0 additionally claims for increased technical skills to support proactive attitude of workers in exploiting the potentials of digitalisation.

5 Conclusions

In the light of the changes that are affecting the workforce requirements in the Industry 4.0 era, this paper aimed at shedding light on the evolution of the concepts referred as Job Enlargement and Job Enrichment. Through the analysis of the academic literature, it has been possible to observe that the two concepts, born in the 60s in the work organisation domain, mutated over the years, being influenced first by the principles of lean production and then by the introduction of automation and digitization of production processes introduced by the so-called Industry 4.0. The study highlighted that if the lean principles strongly promoted the idea of enlarging and enriching the workers' activities to promote their involvement and motivation, supporting leadership attitude and soft skills, additionally the Industry 4.0 significantly affected an enlargement of tasks in space and time, requiring enriched technical skills to manage complex digitized processes.

The main limitation of the presented research is manifested in its purely theoretical nature. In fact, the considerations about the evolution of job enlargement and job enrichment concepts emerging from our analysis derive only from academic literature, while managerial perspective related to industrial real cases is still omitted. However, the results discussed in this paper represent a preliminary phase of a research stream that will be further developed, involving experts both from academia and industry, to propose a new and updated definition of the two concepts considering the most recent advances in manufacturing, and evaluate new methods and criteria for their effective implementation. In particular, some elements deserve special attention and require further investigation in the future, such as X-skilling strategies (e.g. up-skilling, re-skilling, cross-skilling, expert-skilling) and job enrichment and job enlargement efforts.

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