

Employment of autistic people in manufacturing environments: a theoretical overview of the phenomenon and assessment of the current Italian situation

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Abstract: Inclusiveness stands as a foundational tenet within Industry 5.0, a framework that fosters human-centered individual diversity. Within the realm of diversity factors, particular relevance in the social context is held by what is termed "neurodiversity," denoting different functioning of cognitive processes. Among the spectrum of neurodiverse conditions, autism represents an important form of diversity that necessitates considerations by companies, as appropriate adaptations can transform atypical characteristics into unique strengths. However, despite the importance of inclusion, individuals on the autism spectrum remain significantly underemployed, as companies frequently overlook their potential contribution. This study aims to examine the specific circumstances within the Italian manufacturing sector, identifying existing inclusion practices and comparing them with global best practices. An exploratory literature review useful to investigate the inclusion practices of manufacturing contexts towards autistic people is followed by a second part, carried out through a survey, aimed at understanding what is the feedback in such terms in today's Italian manufacturing environment. The results confirm, even for the Italian reality, a low percentage of employment of autistic individuals coupled with a pervasive lack of awareness among companies regarding the potential added value such individuals offer, on the requisite tools and strategies for maximizing their value. In this regard, the research conducted can serve as a useful guiding tool for devising interventions to mitigate the difficulties faced by individuals across the spectrum. In this way, interested companies could benefit from hiring such resources not only from in terms of reputation, but also in practical operational terms.

Keywords: Neurodiversity, Autism, Production Engineering, Industry 5.0, Human-Centered Manufacturing

1. Introduction

Inclusivity is a fundamental prerequisite of the Industry 5.0 paradigm, a human-centered production system in which workers are supported by technology in executing their tasks. Numerous studies have elucidated the positive correlation between cultivating an inclusive and diverse corporate ethos and amplifying productivity and competitive advantage within businesses (Dike, 2013). It is precisely heterogeneity that constitutes an intrinsic feature of human nature, something that an inclusive work environment should valorize. Within the spectrum of diversity, the field of 'neurodiversity' is gaining particular relevance, given the high prevalence of such conditions within the social fabric, which can be estimated at around 15-20% of the world's population (Doyle, 2020). The term 'neurodiversity', originally coined by Australian sociologist Judy Singer in 1998, refers to the different ways cognitive processes occur in humans. The meaning has changed over time, and today, rather than referring to a condition, syndrome, or disease, the term 'neurodiversity' defines atypical neurological development as a natural variation of the human brain. Conditions such as autism, attention deficit hyperactivity disorder (ADHD), and dyslexia, among others, fall under this definition. The scientific literature shows how the employment of neurodiverse people can be a key resource for the success of

companies. That's the case, for instance, of autistic people in IT companies that, thanks to their special computing and coding skills, often go beyond the abilities of the neurotypical person (Annabi and Locke, 2019). However, beyond this specialized workforce, it becomes apparent that autistic individuals, in particular, comprise a significantly underemployed demographic. This is evidenced by the starkly elevated unemployment rates of the autistic population across various nations - over 90% in Italy (anffas.net). It can be inferred, therefore, that the level of adoption of inclusiveness tools to date does not seem to be applied appropriately, which makes the manufacturing reality far from applying the human-centered principles of I5.0.

Hence the need, the following paper aims, to provide an overview regarding the employment of autistic people – whose prevalence in Italy is estimated to be 1,3% (salute.gov) – within today's manufacturing reality. This overview is to be acquired firstly by means of an exploratory literature review, to better understand the issue and the best practices adopted by manufacturing companies at a global level. Subsequently, a survey will be conducted to discern the comparative landscape within the Italian context. This dual-phase approach seeks to enlighten companies regarding the advantageous contributions that autistic individuals can proffer within

manufacturing environments. Following this first introductory paragraph, the paper is structured into five different sections: section 2 describes the methodology used for the research regarding the analysis of the literature and the creation of the questionnaire; section 3 is dedicated to the description of the context - based on the concepts and insights gained from the literature review - useful to give a picture of the current situation regarding the employment and inclusion of autistic individuals. Section 4 entails the analysis of quantitative primary data garnered from a survey distributed among personnel across various Italian companies. This section meticulously examines the insights gleaned from the survey responses, shedding light on the perceptions and practices prevalent within the Italian manufacturing milieu. The paper concludes, through sections 5 and 6 with an analysis of the evidence obtained for the purpose of discussion and conclusion.

2. Methodology

The research has been structured in three macro-phases. The initial phase of the study involved an exhaustive examination of the extant literature on the subject matter. This was undertaken with the objective of delineating the context of the study, and in particular, to identify the typical job characteristics of an autistic person in terms of both their abilities and the difficulties they may encounter in the workplace. Secondly, the employment conditions of autistic individuals within companies were described, with particular focus on the barriers present to their employability, the best practices implemented by companies to foster effective integration of autistic people into the workforce, and the consequent benefits accruing to both the company and the individual. The search, filtered by considering articles published in scientific journals and/or conference papers – available on Scopus database – released from 2012 to 2023, yielded 453 initial articles. The search query was constructed by including terms related to five semantic areas of interest, namely i) autistic condition, ii) work context, iii) application case, iv) inclusivity and v) normative regulation. From here, all articles focused on the school environment were discarded. By filtering the remaining sample for consistency with the research area based on reading the title and abstract, a final set of 37 articles was obtained.

Secondly, a survey addressed to companies was drafted to highlight the state of progress of the Italian manufacturing context, compared to the situation reported in literature, towards a greater inclusiveness of autistic people. More specifically, the questionnaire aims to collect information from companies in relation to the rate of employment of autistic resources, to the benefits and criticalities observed after their employment, to the solutions implemented (if any), and to the company's sensitivity on the issue of inclusion. The questionnaire, disseminated among 1248 companies, is structured into three main sections.

Table 1: Survey structure

*Question used for the cluster analysis

**Sensitivity analysis

| Section | Sub-Section | Question | | |
|--|-------------------------------------|--------------------------|----|-----------------------|
| 1. Company Information | // | -Affiliation | | |
| | | -Sector (etc.) | | |
| 2. Autistic Presence | 2.1. Absent | -Absence reasons | | |
| | | -Willingness to hire | | |
| | | -Company Benefits* | | |
| | 2.1.A. Absent → Willing to hire | -Company | | |
| | | -Criticalities | | |
| | 2.1.B. Absent → Not willing to hire | -Desired Incentives | | |
| | | -Willingness to hire | | |
| | 2.2 Not Aware | -Company Benefits* | | |
| | | -Company | | |
| | | -Criticalities | | |
| 2.2.B. Not Aware → Not willing to hire | -Desired Incentives | | | |
| | -Kind of Autism | | | |
| 2.3 Present | | -Number and role | | |
| | | -Support tools | | |
| | | -Company Benefits* | | |
| | | -Company Criticalities | | |
| | | -ASD strength/weakness | | |
| | | 3. Company Sensitivity** | // | -Diversity acceptance |
| | | | | -Support strategies |
| -Inclusion Policy | | | | |
| -Social interest | | | | |
| -Ethic | | | | |

Initially, company-specific information is gathered, providing essential context for subsequent analysis. The second part of the questionnaire unfolds across three distinct sections, tailored to the company's current status regarding the inclusion of autistic individuals in its workforce (presence of autistic employees, absence, lack of awareness about their presence). Concluding the questionnaire, the third part endeavors to gauge the degree of sensitivity exhibited by the companies toward the issue of inclusion, in terms of organizational ethos and commitment, thereby enriching the overall understanding of the prevailing attitudes within the surveyed companies. In regard to the sensitivity analysis, respondents were requested to indicate the extent to which they agreed or

disagreed with 11 distinct statements. This was accomplished through the use of a Likert scale, with a score ranging from 1 to 4 (1 = "strongly disagree," 4 = "strongly agree").

In the final phase, the analysis focused on understanding the perceived benefits of employing autistic personnel. The presence of discernible clusters, within the sample of analyzed companies, was examined utilizing the statistical software STATA, useful to clusters through dendrograms. The decision to adopt cluster analysis as a methodological approach is motivated primarily by its capacity to comprehensively and purposefully represent the multifaceted landscape of perceptions and attitudes toward employing autistic personnel among manufacturing companies. It facilitates the identification of both common trends and elements of diversity among Italian companies, thereby providing a foundation for the formulation of inclusion-focused strategies that can be implemented to enhance the recruitment and retention of this demographic in the workforce.

3. Labor market characteristics for autistic people

The term “neurodiversity,” coined in 1998 by sociologist Judy Singer, refers to “variation in neurocognitive functioning”, namely, a different functioning of cognitive processes such as: perception, attention, memory, learning, thinking, decision making, and language. Among the principal ones, autism spectrum disorder (ASD) is a lifelong neurodevelopmental condition that affects communication and behavior (Scott et al., 2019). Despite these common conditions, autism is referred to as a spectrum because it includes different interrelated diagnoses. In particular, “high-functioning autism” refers to all those forms that do not involve intellectual impairments or deficits, unlike forms of autism with comorbidities, in which the diagnosis of autism is combined with additional pathologies. Within the work context, statistics show very low employment rates of people with autism, even worse than other diversities (Scott et al., 2019). Indeed, from a business perspective, including a category such as autistic people can be complicated due to the sheer number and diverse support required, especially in the manufacturing sector. There are several critical issues that autistic people face on their journey to employment. They generally stem not only from the physical environment but also a lack of awareness among colleagues and managers (Robertson, 2010) about the characteristics of their condition, resulting in stereotypes that serve as barriers to the inclusion of such people (Spoor et al, 2021).

3.1 Working characteristics

Autism, in its high-functioning form, has some enduring characteristics. Some of these make the autistic person a fragile individual who needs support, while others represent strengths that add value to the company.

Table 2: Strengths & weaknesses of autistic workers

| Category | Capacity/ Difficulty | Factor |
|----------------|-------------------------|---------------------------------|
| Cognitive | Capacity | Information processing |
| | | Logical, analytical thinking |
| | | Pattern recognition |
| | | Detection of errors |
| | | High concentration |
| | | Excellent memory |
| | Difficulty | Understanding instructions |
| | | Emotional self-management |
| | | Narrow interests |
| | | Following the work standard |
| | | Inappropriate behavior |
| | | Difficult social interactions |
| Physical | Capacity | Difficult working in teams |
| | | Communication problems |
| | | Performing repetitive tasks |
| | Difficulty | Work efficiency and accuracy |
| | | Listening and/or speaking |
| | | Need for personal space |
| Organizational | Capacity | Repetitive movements |
| | | Low absenteeism |
| | | Aptitude for using technology |
| | Difficulty | Honesty |
| | | Inflexibility, need for routine |
| | | Managing time |
| | | Manage task responsibility |

When analyzing the traits that can bring value to the organization, several personal skills emerge, such analytical skills and the strong propensity for problem-solving. Fact, this latter has made the deployment of such people popular in the IT world over the past few years (Annabi and Locke, 2019; Morris et al., 2015). Similarly, autistic people possess a strong photographic memory, capable of retaining notions and details for longer periods than neurotypical individuals, especially in all those areas of interest where autistic people demonstrate strong curiosity and willingness to learn (Hayward et al., 2019). Meticulousness in the use of standardized and consistent procedures (Annabi and Locke, 2019) and the systematization of information cataloging (Baron-Cohen et al., 1999) constitutes an additional standout feature, which makes such people ideal in conducting repetitive tasks with precision over the long term (Tomczak, 2021). Some other characteristics are not easily frameable or may

manifest as both strengths and weaknesses, depending on the situation or behavior required by one's role. These include disinterest in office politics at the expense of focusing solely on completing assigned tasks (Baldwin et al., 2014).

Finally, considering the more challenging peculiarities that autism entails, they can be divided into three macro-areas. The first relates to perceptual hyper-functioning, that is, increased perception and vulnerability in processing and manipulating sensory information that can make the work environment distracting (American Psychiatric Association, 2013; Hedley et al., 2018). The second encloses characteristics caused by a deficit in social cognition, meaning difficulty in social understanding and decoding nonverbal modes of communication (Harmut et al., 2018). People on the autism spectrum also show difficulty in emotional self-management, which often results in inappropriate emotions being expressed in the workplace (Hillier et al., 2007; Muller et al., 2003; Morris et al., 2015). The last macro-area includes features related to executive function deficits, which causes autistic individuals to have difficulties with planning and cognitive flexibility (Oliveras-Rentas et al., 2012), whether in terms of time management (Muller et al., 2003) or multitasking (Howlin et al., 2004). Dependence on routine and cognitive inflexibility contribute to arduous adaptation to new colleagues (Morris et al., 2015) and new ways of working (Muller et al., 2003). The communication difficulties typical of autism represent an element of disadvantage for autistic workers compared to their neurotypical counterparts and force employers to adopt specific solutions. People in the autistic spectrum tend to be sociable at the wrong time, not following the rules of conversation and social norms, making the approach critical even for neurotypical people (Hedley et al., 2018; Hillier et al., 2007).

3.2 Benefits

Including people on the autism spectrum in manufacturing settings would have positive repercussions not only on the quality of life of the individuals but also on the social status of the companies themselves, which would experience a reputational improvement (Fombrun, 2005). This increase in social responsibility would come, primarily, through initiatives aimed at training neurotypical workers to interact with autistic people. This would result in greater awareness and sensitivity to differences, thus generating a much more comprehensive and substantial positive change (Austin and Pisano, 2017). The benefits for the company can also be seen in terms of communication (Austin and Pisano, 2017), as having to deal with resources belonging to the autism spectrum compels colleagues and managers to adapt their communication skills to adequately collaborate with such people (Whelpley and Perrault, 2021). If communication is effective, it can result in increased productivity since it enables the effective cooperation of autistic and neurotypical staff within diverse teams, who demonstrate a greater aptitude for problem-solving and innovation (Mello and Rentsh, 2015).

From the opposite perspective, at the individual level, data show that the productivity and efficiency of the autistic person, once assigned to a task that meets his/her abilities, outperforms that of neurotypical colleagues by between 50 percent and 90 percent, with only minimal requests for adaptations of the work environment (Sullivan and Kearney, 2018).

4. ASD workforce in the Italian Manufacturing landscape: results of the survey

In order to gain insight into the current state of affairs regarding the employment of individuals with autism, and to assess the level of awareness regarding this topic, a survey was distributed to 1248 Italian manufacturing companies. Of these, only 65 (5,21% of all contacted companies) responded to the questionnaire. To the specific question “Are there any individuals on the autism spectrum in the company?”, 12 answered in the affirmative, 40 denied the presence of autistic personnel, and 13 were not aware of it. As briefly reported in Table 1, depending on the answer given by companies regarding concerning the potential existence of autistic employees within its personnel, each participant was directed to a specific section of the questionnaire in Part 2.

4.1 Absent

When asked regarding the primary causative factor contributing to the underrepresentation of individuals with autism spectrum disorder within the corporate workforce, 31 companies attribute the reason to a missed hiring opportunity. This oversight is ascribable - in all likelihood - to the fact that “traditional” job interviews tend to put autistic people at a disadvantage, precisely because of the need to make a “good impression”, especially in terms of social skills (Whelpley and Perrault, 2021). This implies the need for companies to adopt ad-hoc selection methodologies for the inclusion of this category within their staff. Regarding a possible future intention on hiring autistic personnel, only half of the companies (20) state that they would be interested in such a possibility, in view of consolidating their position in social engagement (11).

Commonly reported difficulties included the complexity of adapting labor roles to accommodate the unique needs of autistic individuals (8) and a lack of knowledge about integration strategies (8). To encourage the adoption of inclusive policies, companies expressed a desire for special government subsidies (10) as well as assistance in devising and implementing tailored solutions (9).

4.2 Not aware

Among the 13 companies in this category, only one was negative about the possibility of hiring neurodiverse resources, due primarily to difficulties associated with adapting the work and a lack of knowledge about how to integrate them appropriately. The remaining companies indicated that increasing social responsibility (10) and

diversifying team perspectives (5) would prompt consideration of hiring autistic staff.

4.3 Present

Among the 12 companies that already have autistic staff in their workforce, 8 employ high-functioning autistic people, 2 individuals with comorbidity, and 2 both categories.

Among the benefits, increased social responsibility is the most commonly found (8). Such fact provides a positive response to the wishes of companies interested in employing autistic people, who desire an enhancement of social responsibility. Similarly, in terms of merits related to the individual person, there is evidence of a marked predisposition of autistic people toward performing repetitive tasks and activities (9) and the honesty of such employees (5). On the other hand, considering the critical issues arising from the employment of people belonging to the autism spectrum in the manufacturing work environment, companies point to the lack of special laws protecting the autistic category in the work environment (7). Neurodiversity, in fact, is not regarded by Italian legislation with the same regard as a generic form of disability and, for that reason, is less guarded. Next, the high cost of environment adaptation to the autistic worker (3) and the unwillingness to share their own condition (3) are the secondary critical issues indicated by companies. At the individual level, the main issues reported about the persona include difficulty in concentrating (6) and following work standards (4), the need for routine (6), and difficulties in time management (3) and listening and/or speaking (6).

4.4 Company awareness and sensitivity

In the third section companies were asked about their approach to inclusivity, with particular reference to inclusion policy, ethical code and supporting strategies. It is surprising that more than half of the firms without autistic staff (60%) or unaware of their potential presence (54%) expressed reluctance to hire individuals on the autism spectrum, despite the fact that the rest of the sample did not reveal any particular critical issues from employing autistic staff.

25% of companies employing autistic staff agreed to the statement “I have witnessed cases of discrimination or prejudice in the workplace”, the highest percentage among all the categories considered. This could be explained by the fact that since the company has an additional element of diversity, it is more likely to witness discrimination or prejudice, especially at an early stage. This underscores the necessity for the implementation of neurodiversity awareness initiatives targeting the individuals who constitute the corporate workforce.

5. Cluster analysis of companies on perceived benefits

On the one hand, the literature recognizes a whole series of traits belonging to the autism spectrum that would contribute to increased business performance; on the other hand, the survey responses show that the degree of inclusion of autistic people in companies is still inadequate if compared to the average number of autistic individuals in the society. In fact, companies recognize only some of the benefits from hiring this category, especially those that are more intangible and “cosmetic”. To delve deeper into the underlying motivations behind this behavior, a cluster analysis was undertaken based on the perceived benefits of potentially hiring autistic personnel.

In the cluster analysis that follows, 23 companies were excluded as they see no benefit in including autistic individuals in their workforce. Such amount confirms, once again, the insufficient awareness regarding the autism condition within the surveyed sample, ultimately resulting in limited opportunities for people with autism.

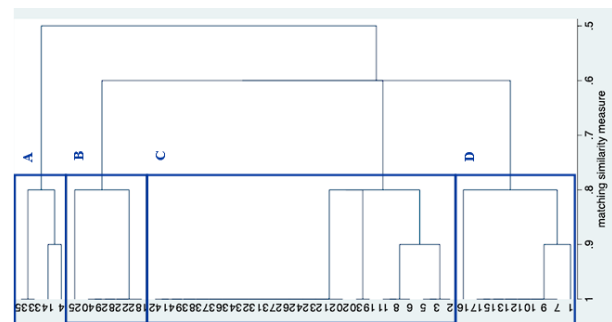


Figure 1: Dendrogram representation of manufacturing companies based on perceived benefits

5.1 Cluster A

All those companies that have recognized autistic people as showing strong loyalty towards the company affiliation (although only one integrates this category of people into its workforce) are gathered within this cluster.

5.2 Cluster B

The second cluster is made up of six companies (among which, only one employs autistic personnel within its workforce), all of whom claim to be willing to hire people without any discrimination whatsoever, whether they are neurotypical or not. The only discriminant consists in passing the selection process; in practical terms, it is only required that the person interested in the position has all the required skills to be hired. This very aspect, however, represents one of the main barriers to employment entry for people with autism. As seen in the literature, in fact, such people are often unable to get through traditional job interviews because of their discomfort in social interaction, which is the reason why the company must provide a selection process designed specifically for their needs. Thus, paradoxically, the very desire to be inclusive by using a standard selection process for each individual,

actually turns out to be the primary reason for the exclusion of neurodiverse people from work contexts.

5.3 Cluster C

The third cluster identified, the largest, consists of 23 companies, most of whom believe that only the most intangible benefits would be obtained from hiring autistic people (reputational feedback). This cluster is representative of the result that emerged from the survey: the inclusion of Italian companies is not yet effective because of the lack of awareness regarding the operational benefits that autistic people bring. Thus, it can be said that Italian companies are indeed taking steps toward inclusiveness, but it seems they have still not found the key to making the integration of such people fruitful, both for the autistic people themselves and for the company. It is interesting, for the companies belonging to this cluster, to note that most of the respondents mostly belong to the positions of CEO (9) and HR (5), a fact that may explain how the prevailing perception of benefits related more to the reputational part may be ascribable to the fact that such figures are, on the one hand, more focused on the company's image and, on the other hand, not close to the production processes, and so they may not have a clear idea of the productive benefits that come from hiring autistic people. Ultimately, the vision type determined by the job position could affect both the awareness of what is really going on and the tendency to give more priority to the reputational aspect resulting from the inclusion process, which is of more obvious and rapid effect.

5.4 Cluster D

The last cluster is composed of companies (9) that experience greater innovativeness in hiring autistic personnel due to the multiplicity of viewpoints resulting from the composition of heterogeneous teams. Indeed, the companies themselves state that they would be interested in possibly hiring neurodiverse individuals not as much because of a legislative obligation, but rather because of the existence of a real desire to include this category within the company workforce.

Ultimately, within the heterogeneity of the clusters identified, no predominant orientation appears on the vision of the benefits achievable by the inclusion of autistic personnel within the workplace. The only evidence, in this sense, that links different clusters concern the awareness related to more “reputational” or, rather, social benefits. This preference, in particular, could have two underlying reasons. A first cause might be the lack of knowledge of the intrinsic characteristics of this category of people, leading to only ephemeral inclusion. Likewise, a second cause might derive from the difficulty of identifying a role (or task) that can enhance the autistic individual, who instead turns out to be often unable to perform his/her tasks. This inevitably undermines productive performance and makes it difficult to recognize the various benefits that these individuals can bring to the organization.

6. Conclusion

The objective of the paper was to identify the inclusion strategies adopted by Italian companies to encourage the employment of individuals with autism spectrum disorders (ASD), with a focus on the perceived benefits and limitations (as identified in the scientific literature on the subject) that arise from integrating such resources within the workforce. First, what emerged from the literature analysis is a compendium of positive factors observable at the company level, such as improved general communication, heterogeneity of viewpoints, improved reputation and increased social commitment. In addition, all the characteristics peculiar to the autistic spectrum have been identified, especially those that contribute to render such employees as effective resources in manufacturing realities. Analytical thinking skills make these individuals strongly problem-solving oriented. Furthermore, their photographic memory and high tolerance for repetitive and monotonous actions represent strengths that often exceed the capabilities of their neurotypical counterparts. However, there are likewise numerous characteristics distinctive to autism that require corrective interventions, both environmentally and organizationally.

At this point, the study aimed to understand whether the notions found in the literature found a concrete match in today's Italian manufacturing companies. Through a questionnaire administered to more than 1,000 Italian companies belonging to different manufacturing sectors, it was found that the percentage of companies actively hiring autistic individuals is extremely low. This is mainly due to the fact that, as the cluster analysis shows, the greatest benefits reported from companies concern merely and increased social responsibility. This very aspect testifies to little willingness in actually striving to ensure that the integration of the category within the manufacturing world is rooted, and not limited to the mere "social" aspect that underlies most of the initiatives fielded to date.

In general, it seems that Italian companies have not yet found the key to fully exploit the potential of autistic people, especially in terms of performance. To address this problem, it would be important to implement useful initiatives to increase companies' awareness about the peculiar potential of autistic people, while giving on-the-job support in the process of adjusting the work environment. From a research perspective, further studies in this area would facilitate a deeper understanding of the trends that emerged from the general framework described in this paper. In particular, it would be beneficial to gain insight into how contemporary manufacturing paradigms, such as those of Industry 5.0 or Lean Manufacturing, could be employed as compensatory tools for individuals with neurodiversity. Although there are already theoretical models that address the applicability of support tools for neurodiverse individuals (Zanchi et al., 2024), a field validation process could prove invaluable for companies seeking to integrate neurodiverse workers in a more structured manner. Such a process would enable companies to ascertain the actual degree to which such

practices and techniques support neurodiverse workers, thereby leading to relevant and visible outcomes.

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