Job Satisfaction and Work Characteristics Combinations in Industry 4.0 Environment—Insight from the Polish SMEs in the Post–Pandemic Era

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Abstract: The development of Industry 4.0, which has been observed for many years, spans the period before, during, and after the COVID-19 pandemic. This concept, which describes the complex process of business transformation, is reflected in a growing number of studies showing that the aim of Industry 4.0 is not to eliminate the human factor, but to introduce effective collaboration between people, systems, and machines. The success of a company depends to a large extent on the efficiency and productivity of its employees, to which job satisfaction is directly related. Job satisfaction is a phenomenon influenced by many factors, including job characteristics. Recognition of the relationship between job satisfaction and job characteristics throughout the implementation of Industry 4.0 solutions is marginal. Therefore, an attempt was made to identify the relationship between job characteristics and the achievement of job satisfaction in the digital transformation era by conducting a survey among Polish SMEs after the COVID-19 pandemic. The survey used the fs/QCA method. The results of the study contribute to SME theory and practice by identifying different combinations of job characteristics leading to high and low job satisfaction in an Industry 4.0 environment.

Keywords: job satisfaction; work characteristics; COVID-19; Industry 4.0; fuzzy-set Qualitative Comparative Analysis (fs/QCA)

1. Introduction

The Fourth Industrial Revolution, known as Industry 4.0, is driven by continuous technological, socioeconomic and political change [1]. The idea of Industry 4.0 was launched in Germany in 2011 [2], where the term was first used during the presentation of the future of the industry at the Hanover Fair [3]. The Fourth Industrial Revolution is based on the deployment of several technologies that enable new digital production systems, the collection, sharing, and analysis of data in real-time, and the linking of cyberspace with the real environment [4]. Industry 4.0 is mainly associated with various technologies such as the internet of things, cloud computing, cognitive computing, artificial intelligence, and cyber-physical systems [5]. Implementing Industry 4.0 solutions can reduce costs, increase flexibility and improve quality. It can also influence productivity by alleviating some of the tension between the identified key operational priorities [6]. Companies with a greater level of automation and digital maturity through the integration of Industry 4.0 technologies are able to maintain high levels of productivity, which in turn affects their ability to survive and even develop in a turbulent and highly competitive environment. The implementation of Industry 4.0 solutions takes place under the concepts of digital transformation and digitization. Digital transformation includes the implementation of digitization projects that result in strategic changes and business improvements, while digitization combines aspects of everyday life with different technologies and is a socio-technological process [7]. Under the influence of digitalization, the labor market has undergone significant changes over the last decade. New digital technologies are determining changes in the qualification requirements...
of occupations for which people have been educating and preparing for years [8]. Digital transformation has a huge impact on society and the economy as a whole and includes the use of digital technologies in all spheres of life [9]. Virtual reality, speech recognition, and the use of augmented reality will change the way tasks are carried out, which means that the changes resulting from Industry 4.0 cannot be ignored, even less so in the area of the human factor. Today’s global economies are facing numerous challenges of digital transformation, such as the education system and the new role of universities, resource scarcity, insufficient investment in new technologies, the insufficient digital maturity of some economies, and cybersecurity. The emergence of the Fourth Industrial Revolution is reflected in a number of analyses and studies conducted from different perspectives, including companies, regions, and countries, as the changes caused by the implementation of Industry 4.0 solutions do not only concern industry or enterprises but also influence the dynamics of socio-economic processes. The literature on Industry 4.0 mainly deals with technological changes, rarely taking into account the human factor in these studies and the fact that the increasing degree of digitalization in small and medium-sized enterprises possess a significant challenge for managers. Although, in this era of digital transformation, many processes have been automated or these processes are supported by smart technologies, employees are the foundation of any business and the changes being made. However, the concept of “Industry 4.0” requires workers to continuously develop, improve their qualifications, and be coached to cope with new technological improvements. The constant changes brought about by digital transformation and the speed at which they are introduced can lead to the employees feeling confused, unappreciated, or even dissatisfied in their workplace. The job satisfaction of employees is a widely researched but poorly understood phenomenon in organizations, especially in the context of the Fourth Industrial Revolution.

Work characteristics are one of the many factors associated with achieving employee job satisfaction. Despite many studies on job satisfaction, the relationship between job characteristics and job satisfaction, especially in the context of the Fourth Industrial Revolution, has not yet been the subject of empirical analysis. Therefore, this article attempts to examine the relationship between job characteristics and job satisfaction in the Industry 4.0 environment. The article is structured as follows. The first part describes the theoretical framework on two constructs: job satisfaction and work characteristics, and their interrelationship in the conditions of Industry 4.0. The next parts include: description of methods, materials and presentation of results. The last part is a discussion and conclusion.

2. Theoretical Background

Job satisfaction is a term that reflects employee satisfaction and is used to indicate whether employees are struggling and getting their wants and needs met [10]. One definition of job satisfaction states that it is employees’ perceptions of the amount of pay they should receive in exchange for the different amounts of rewards they are given [11]. According to Bentley et al. (2013) [12], job satisfaction is an individual’s level of satisfaction with the compensation they receive, differentiated in relation to different aspects of their job. Choi and Joung (2017) [13] describe job satisfaction as a psychological state of employees that is a consequence of the evaluation of their performance at work. Schermerhorn et al. (2012) [14] define job satisfaction as “an attitude that reflects a person’s feelings about their job or work environment at a particular point in time”. Bailey et al. (2016) [15] identified five dimensions of job satisfaction. These are: (1) the work itself, (2) supervision, (3) employees, (4) promotion, and (5) compensation. According to Yu et al. (2019) [16], job satisfaction is an employee’s overall satisfaction with several factors, which include: workplace, supervisor support, co-workers, the work environment, or workload. Adhering to Sowmya and Panchanatham (2011) [17], “A happy employee is a productive employee”, which according to them translates to the fact that employees who are satisfied with their jobs and feel happy in their jobs are more engaged, more productive, and less likely to quit. In addition, employee job satisfaction contributes to the achievement of enterprise goals
because the rewards or facilities provided by an organization make employees feel safe and comfortable both mentally and physically [18]. Armstrong (2003) [19] links favorable and positive work attitudes as determinants of perceived job satisfaction. He indicates that unfavorable and negative attitudes are indicative of job dissatisfaction. Similarly, Adiguzel et al., (2020) [20] argue that job satisfaction will be represented by an employee’s positive or negative behavior in the workplace. Moreover, job satisfaction can be treated as a value in itself, as it also contributes to the implementation of the concept of sustainable social development [21], which is particularly important in connection with the challenges of the Fourth Industrial Revolution in the context of changes taking place in socio-economic processes.

The success of a business will depend on the efficiency and productivity of its employees, to which job satisfaction is directly related [22]. Empirical discernment of the direct impact or relationship between digitization and employee job satisfaction is scarce, as is the investigation of the achievement of job satisfaction under digital transformation. The available literature theoretically assumes a link between digitalization and job satisfaction in two ways, that is, digitalization can affect employees’ job satisfaction in a positive way or in a negative way. Generally, the scant literature in this area indicates a positive relationship between digitalization and employees’ feelings and achievement of job satisfaction [23,24].

Achieving employee job satisfaction has been a phenomenon that has been analyzed for many years, but in the context of Industry 4.0, it is still a poorly understood area. One of the factors related to employees’ job satisfaction is job characteristics, and although there have already been some attempts to discern job satisfaction under the conditions of the Polish economy [25,26], the relationship between job characteristics and job satisfaction under the conditions of digital transformation has not been yet analyzed.

The analysis of the literature showed some differentiation between the terms “work characteristics” and “job characteristics”, although these terms are often used interchangeably. Authors pointed out that “work characteristics” has a broader context of work and its environment than “job characteristics” [27]. Although “job characteristics” is a term even more frequently used in publications in this area, in this paper we use the term “work characteristics”.

The Job Characteristics Model in its first version [28] included four job characteristics. In 1975, Hackman and Oldham (1975) [29] included task significance as a fifth characteristic that determines work behavior. The Job Characteristics Model assumes that if employees achieve three psychological states, that is: perceiving their work as meaningful work, feeling responsible for the results of their work, and having knowledge of the results of their work, they will show positive results both professionally and personally. These outcomes include overall job satisfaction and intrinsic motivation. Morgeson and Humphrey (2006) [27], developing the Job Characteristics Model, created the Work Design Questionnaire (WDQ). This comprehensive tool covers the main job characteristics such as (1) skill variety, (2) task meaning, (3) task identity, (4) autonomy, and (5) feedback, and it was expanded to include: “knowledge characteristics”, “social characteristics”, and “contextual characteristics” [27]. The Job Design Questionnaire is used to assess the job characteristics that lead to job satisfaction, thus providing an opportunity to analyze job satisfaction in the era of the Fourth Industrial Revolution. Work design combines job characteristics such as organizational, social and work elements that can determine individual and organizational interests and outcomes [30]. Work characteristics include four main groups of features and elements connected with work [27,31]. These are (1) task characteristics; (2) knowledge characteristics; (3) social characteristics; and (4) contextual characteristics. The first group of task characteristics includes the autonomy of work planning, the autonomy of decision making, the autonomy of work methods, task variety, task meaning, task identity, and job feedback. Task characteristics are related to the scope and nature of the job tasks as well as to the way the job itself is performed. The second group, knowledge characteristics, includes job complexity, information processing, problem solving, skill variety, and specialization. Knowledge characteristics refer to the knowledge, skills, and abilities required. Group three, social characteristics, include social support, interdependence initiated, inter-
dependence received, interactions outside the organization, and feedback from others. This group of job characteristics relates to the level as well as the type of personal interactions that employees maintain in their work. The last group is Contextual characteristics, and includes ergonomics, physical demands, working conditions, and equipment use.

Research confirms that work characteristics influence job satisfaction [32], but no empirical study to date has examined this relationship in Industry 4.0 conditions in small and medium-sized enterprises that have reached a high degree of digital maturity.

**Proposition 1.** Work characteristics lead to job satisfaction in the conditions of digital transformation.

**Proposition 2.** Different combinations of task, knowledge, social and contextual characteristics simultaneously lead to job satisfaction in the conditions of digital transformation.

Taking after Neumann et al. (2021) [33], the lack of consideration of the human factor in Industry 4.0 will have detrimental effects on employees, organizations, and society as a whole. Human resources are the main and integral component of any organization, regardless of its form or purpose. Job satisfaction refers to the subjective perception of how a person feels at work. This is why, in the current situation, it is necessary to study and analyze the factors that help workers to increase or achieve job satisfaction, even more so under the conditions of crisis, recently caused by the COVID-19 pandemic or the war in Ukraine. Moreover, the analysis of these factors has its theoretical justification, since Industry 4.0 is a sociotechnical system in which people are involved [33]. Small and medium-sized enterprises (SMEs), which are the backbone of the economies of most countries in the world, are the leading source of employment and contribute to sustainable economic growth [34].

The existence of a relationship between work characteristics and job satisfaction is indisputable; however, recognition in this area in the era of the Fourth Industrial Revolution is marginal. Therefore, an attempt was made to identify the relationship between work characteristics and achieving job satisfaction in the era of digital transformation. The aim of this study is to identify different combinations of work characteristics that lead to job satisfaction in Industry 4.0 conditions, i.e., in manufacturing small and medium-sized enterprises that have implemented Industry 4.0 solutions. Figure 1 shows a research model.

![Figure 1. Research model. Source: own study.](image)

3. Materials and Methods

This study uses a configuration approach based on set theory and fuzzy algebra [35], namely fs/QCA (fuzzy set qualitative comparative analysis). Fs/QCA is especially suitable for studying complex causality and multiple interactions [36–38]. This methodology offers a set-theoretical approach to causality analysis as regards conditions and the outcome [35]. In this method, the different combinations contribute to the clarification of the outcome.
Recently, this approach has become the subject of interest of many researchers in the fields of innovation and the labor market e.g., [39,40]. Industry 4.0, understood as an ongoing digital transformation, is closely related to innovation issues and strategic changes, and therefore constitutes an appropriate field for the use of the fs/QCA method [41]. It is worth pointing out that QCA is used both for N small and as indicated by Woodside (2012) [42], Fiss (2011) [36], or Greckhamer et al. (2008) [43] for samples with N large (more than 50 cases). Moreover, both small-N and large-N QCA studies can be used to test inductive or deductive theories or theory building [44].

The research consisted of two main stages (see Figure 2). In the first stage, the research sample was carefully selected to provide an insight into the Industry 4.0 area under study, understood as the digital transformation of production and value creation processes based on the experience gained in Polish manufacturing companies. We selected our cases based on the following criteria: the company belongs to SMEs and is not a new venture. On the basis of available data, using to a large extent the databases of companies researched in earlier projects carried out at the Faculty of Organization and Management of the Silesian University of Technology concerning Industry 4.0 of national scope, a list of 365 potential entities (Polish manufacturing SMEs) was created.

![Figure 2. Research procedure using fs/QCA. Source: own study.](image-url)
During the first stage of our research, information was sent with a project description and an invitation to cooperation. A total of 269 companies confirmed their willingness to participate. At this stage, a questionnaire was then sent to high-level managers of these entities. The survey was conducted between February 2022 and March 2022, and respondents took part in an online survey. Respondents answered questions about the level of digital maturity.

In both academia and industry, digital maturity is considered the standard for assessing digital transformation performance [45]. This study uses Gill and Vanboskirk’s (2016) [46] digital maturity assessment model. This model was used to measure the digital transformation in the following dimensions: culture, organization, technology, and insight. Each dimension contained five items, resulting in 20 items rated on a five-point scale (from 1 = strongly disagree to 5 = strongly agree). All the items are presented in Appendix A.

At this stage, 93 manufacturing SMEs belonging to the set of companies with high digital maturity were selected based on the survey results. For this purpose, a calibration process was carried out. Calibration in fs/QCA involves converting the raw data into membership of the set, starting from full non-membership, which equals 0, through 0.5—the crossover point, indicating maximum ambiguity to full membership, which equals 1 [35]. This study uses ordinal Likert scales to identify qualitative anchors (‘strongly agree’, ‘neither agree nor disagree’ and ‘strongly disagree’) that directly inform the calibration thresholds of membership [36].

In the second stage of the research, data was collected through an online survey among employees in 93 Polish manufacturing SMEs selected in the first stage. The survey was conducted between April 2022 and July 2022. After ensuring that the respondent is an appropriate representative of the company and obtaining consent and completing the ethics clause for participation in the survey, as well as indicating company-level variables (company age, company size, industry), the respondent answered questions on the relevant variables presented in random order. Finally, some personal information (e.g., gender, age) was asked for after ensuring the anonymity of the answers. A total of 156 correctly completed questionnaires were obtained. A set of descriptive categories is shown in Table 1.

Table 1. Sample description. Source: own study.

| Category                  | Statistic                                                                 |
|---------------------------|---------------------------------------------------------------------------|
| Firm level                | Manufacture of motor vehicles, trailers and semi-trailers: 19.3%          |
|                           | Manufacture of computers, electronic and optical products: 28.4%          |
|                           | Manufacture of electrical equipment: 31.6%                                 |
|                           | Furniture manufacturing: 17.5%                                            |
|                           | Other: 3.2%                                                                |
|                           | Fewer than 50: 33.3%                                                      |
|                           | 50–250: 66.7%                                                             |
| Industry sector           |                                                                           |
| Firm size (employees)     |                                                                           |
|                           | Male: 76.1%                                                                |
|                           | Female: 23.9%                                                              |
| Gender                    |                                                                           |
| Age                       | 20–30 years old: 33.5%                                                    |
|                           | 31–45 years old: 39.8%                                                    |
|                           | >46 years old: 26.7%                                                      |
|                           | Primary education: 11.2%                                                   |
|                           | Secondary education: 39.9%                                                 |
|                           | Higher education: 48.9%                                                   |
|                           | <10 years: 28.7%                                                          |
|                           | 11–15: 21.9%                                                              |
|                           | 16–20: 37%                                                                |
|                           | >21 years old: 12.4%                                                      |

The second stage of the study used a questionnaire developed from the literature review. All questionnaire items were measured using a five-point Likert scale (1 = strongly disagree,
5 = strongly agree). Cronbach’s alpha for all constructs is above 0.7, reaching the criterion and indicating a high level of internal consistency [47].

The outcome of this study is job satisfaction (Cronbach’s alpha = 0.89), which was measured using the six-item measure of Korff et al. (2017) [48]. The Work Design Questionnaire (WDQ), developed by Morgeson and Humphrey (2006) [27], which is a self-descriptive measure with a total of 77 items using a 5-point Likert scale, was used to assess work characteristics. Cronbach’s alpha was for task characteristics = 0.79, knowledge characteristics = 0.81, social characteristics = 0.90 and contextual characteristics = 0.83, where for the original version of the WDQ this measure ranged from 0.64 to 0.95, with a mean alpha = 0.86. The category system developed by Morgeson and Humphrey (2006) [27] has a strong relationship with job satisfaction and is linked to concepts of intrinsic motivation. Thus, the WDQ enables a comprehensive analysis of job satisfaction under conditions of digital transformation and therefore for SMEs with a high level of digital maturity. The specific items are summarized in Appendix B. Table 2 displays the mean, standard deviations, and correlation matrix for our measures.

Table 2. Descriptive statistics and correlation. Source: own study.

| Variable                        | Mean | s.d. | 1    | 2    | 3    | 4    | 5    |
|---------------------------------|------|------|------|------|------|------|------|
| 1. Task characteristics        | 3.62 | 0.47 | 1.000|      |      |      |      |
| 2. Knowledge characteristics   | 3.70 | 0.48 | 0.543| 1.000|      |      |      |
| 3. Social characteristics      | 3.67 | 0.46 | 0.434| 0.563| 1.000|      |      |
| 4. Contextual characteristics  | 3.43 | 0.61 | 0.251| 0.434| 0.351| 1.000|      |
| 5. Job satisfaction            | 3.45 | 0.78 | 0.233| 0.252| 0.320| 0.421| 1.000|

In the next step in stage two, the fuzzy membership results were calibrated as suggested by Ragin (2008) [35] based on theoretical knowledge and empirical evidence. The study agreed on conceptual anchors consistent with the actual sample distribution, which is recognized in many previous studies e.g., [36,49] when partial knowledge is available. Therefore, the three anchor points (fully in, the crossover point, and fully out) depended on the maximum, mean, and minimum values of the sample.

For example, the maximum observed value (3.319) for the ‘fully in’ set of high job satisfaction was calibrated for the ‘fully in’ set, and the minimum observed value (2.601) for ‘fully out’. The crossover-point was 3.023. To avoid theoretical difficulties at the point of maximum ambiguity (0.5), we added a constant of 0.001 in line with established practice [35,36]. According to the described principle, three reference points were determined for the remaining four variables, i.e., 1. task characteristics, knowledge characteristics, social characteristics, and contextual characteristics. Table 3 shows the calibrated variables for the appropriate fuzzy set.

Table 3. Calibration. Source: own study.

| Conditions                  | Calibration                  |
|-----------------------------|------------------------------|
| Task characteristics        | 4.833 | 4.105 | 3.501 |
| Knowledge characteristics   | 5      | 4.680 | 4.107 |
| Social characteristics      | 4.333 | 3.640 | 2.177 |
| Contextual characteristics  | 4.606 | 3.978 | 3.166 |
| Job satisfaction            | 3.319 | 3.023 | 2.601 |

4. Results

According to the developed research procedure (Figure 2), it was first checked whether any single condition of the work characteristics, namely task, knowledge, social or contextual characteristics is necessary for high or low job satisfaction. Thus, if the consistency coefficient is higher than 0.9, the condition is considered to be a necessary condition for the
outcome [50]. Table 4 shows the results of this analysis. In the aspect of high job satisfaction, one condition reached a value above 0.9, namely knowledge characteristics [35,51]. This condition is therefore considered to be a causal necessity related to the outcome under study, which is high job satisfaction. This finding significantly extends the existing literature on job satisfaction in the Industry 4.0 setting with regard to explanatory conditions. In the context of low job satisfaction, the consistency coefficients of all conditions were below 0.9, indicating that no single condition is a necessary condition for the outcome under study.

**Table 4.** Analysis of necessary conditions. Source: own study.

| Condition                  | High Job Satisfaction | Low Job Satisfaction |
|----------------------------|-----------------------|----------------------|
|                           | Consistency | Coverage | Consistency | Coverage |
| Task characteristics      | 0.771       | 0.727     | 0.684       | 0.587     |
| ~Task characteristics     | 0.554       | 0.653     | 0.683       | 0.712     |
| Knowledge characteristics | 0.910       | 0.903     | 0.771       | 0.545     |
| ~Knowledge characteristics| 0.772       | 0.781     | 0.674       | 0.734     |
| Social characteristics    | 0.593       | 0.675     | 0.698       | 0.589     |
| ~Social characteristics   | 0.771       | 0.758     | 0.753       | 0.696     |
| Contextual characteristics| 0.633       | 0.432     | 0.566       | 0.623     |
| ~Contextual characteristics| 0.687      | 0.594     | 0.781       | 0.684     |

Note. –logical negation—the absence of conditions.

In this article, fsQCA3.0 software was used to analyze the standardized data. Following the research procedure, a sufficiency analysis was performed sequentially using a minimum case frequency benchmark of ≥1 e.g., [51,52] and a raw consistency benchmark of ≥0.8 e.g., [36,37,53].

The results are presented in Table 5. The notation by Ragain and Fiss (2008) [50] uses “•” for the presence of the condition, “⊖” for the absence of the condition and an empty space means ‘don’t care’. The core conditions are shown in large circles and the peripheral (or contributing) conditions are presented in small circles. The analysis identified three combinations of work characteristics leading to high job satisfaction. The overall solution consistency is 0.87, which explains the level of significance of all solutions obtained as a whole. The results show that the three combinations capture 71% of high job satisfaction. Taking advantage of the fact that fs/QCA is not symmetric, unlike other quantification techniques [54], it was also investigated which combinations of factors lead to low job satisfaction since the inverse of the solution for a positive outcome does not always explain the negative outcome. As a result of the analysis, two combinations were identified that may lead to low job satisfaction. Overall solution consistency is 0.83 and coverage is 0.62.

**Table 5.** Combinations of work characteristics leading to job satisfaction. Source: own study.

| Condition                  | High Job Satisfaction | Low Job Satisfaction |
|----------------------------|-----------------------|----------------------|
|                           | C1a       | C1b     | C1c     | C2       | C3     |
| Task characteristics (TaCh)| •         | •      | •      | •       | ⊖      |
| Knowledge characteristics (KnCh) | •      | •      | •      | ⊖      | ⊖      |
| Social characteristics (SoCh) | •       | ⊖      | ⊖      | ⊖      | ⊖      |
| Contextual characteristics (CoCh) | •       | •      | •      | ⊖      | ⊖      |
| Raw coverage              | 0.42      | 0.41   | 0.47   | 0.38     | 0.42   |
| Unique coverage           | 0.21      | 0.02   | 0.03   | 0.05     | 0.11   |
| Consistency               | 0.81      | 0.80   | 0.84   | 0.82     | 0.87   |
| Overall solution coverage | 0.71      | 0.62   |        |          |        |
| Overall solution consistency| 0.87     | 0.83   |        |          |        |

Note. •—core causal condition (present); •—peripheral casual condition (present); ⊖—core casual condition (absent); ⊖—peripheral casual condition (absent); blank spaces indicate “do not care”. Source: own study.
Standard analyses in fs/QCA can present three solutions based on the different treatments of reminder combinations: complex, parsimonious and intermediate [35]. This article presents parsimonious and intermediate solutions.

The final solution for high job satisfaction can be expressed as follows (Formula (1)):

\[
TaCh^{\ast}KnCh + KnCh^{\ast}SoCh^{\ast}CoCh + TaCh^{\ast}KnCh^{\ast}~SoCh^{\ast}CoCh
\]

(1)

were the “\(*\)” sign represents the logical AND and “+” logical OR

In turn, the final solution for low job satisfaction can be represented by Equation (2):

\[
TaCh^{\ast}~SoCh^{\ast}~CoCh + ~TaCh^{\ast}~KnCh^{\ast}~SoCh
\]

(2)

were the “\(*\)” sign represents the logical AND and “+” logical OR

In Figure 3, the scatter plot shows a combination (set) for high job satisfaction for which all calibrated scores are systematically less than or equal to the scores of the outcome (top triangle). Therefore, this set is a subset of the high consistency outcome. Cases below the diagonal do not match the outcome. Those above the diagonal are consistent.

Similarly, the scatter plot in Figure 4 indicates a combination (set) for low job satisfaction for which all calibrated scores are systematically less than or equal to the scores of the outcome, indicating that it is a subset of the outcome with high consistency.
In the sufficiency analysis, assuming after Ragin (2000, 2008) [35,54], when all cases were located above the diagonal, it means that the result membership scores are consistently higher than the causal configuration affiliation scores. Therefore, a causal expression is a subset of the outcome that is a set-theoretical way of expressing sufficiency. The top corner above the diagonal shows the cases that are most compatible with the solution. On the other hand, the top corner below the diagonal represents the most inconsistent cases. Taking into account the numerous representations of cases in the upper corner above the diagonal and their very limited number in the corner below the diagonal, it can be concluded that there are no serious inconsistencies in the presented solutions.

The final stage of our analysis, in line with the research procedure adopted, was a series of robustness checks. As indicated in the literature, ways to assess the robustness of fs/QCA results are (1) different calibration thresholds, and (2) different consistency thresholds [51]. Implementing this step, we generated solutions for lower and higher calibration anchors. We also generated solutions for lower and higher coherence thresholds. Subsequently, we compared the resulting solutions with the baseline scenario that was used during the main analysis. Thus, lowering the calibration anchors in most cases leads to a reduction in the range of the solution and thus in the explanatory power. In contrast, raising the thresholds did not produce any consistent solutions. It should be pointed out that varying the coherence thresholds did not produce any new or logically inconsistent solution terms. Lower coherence thresholds (−0.05) yielded logical supersets of the underlying solutions. Increasing consistency thresholds (+0.05) led to no consistent truth table rows (and thus inaccessible solutions). In summary, varying the consistency thresholds did not
suggest any improvement in our results. The lack of improvement in the results obtained during this stage of the analysis confirms the choices underlying our main data analysis.

5. Discussion

Industry 4.0 or the Fourth Industrial Revolution, refers to the digital transformation in manufacturing, with significant improvements in the way goods are produced and delivered, and is considered a disruptive phenomenon that will significantly affect both industry and society [55]. This article attempts to fill the gap regarding the characteristics of work and their different combinations leading simultaneously to job satisfaction under Industry 4.0 conditions. As digital maturity is the standard for assessing the performance of digital transformation [45], in the first stage of the research, entities with a high degree of digital maturity were selected. In such a selected group of Polish small and medium-sized manufacturing companies, the second stage of the research was conducted using fuzzy/set Qualitative Comparative Analysis.

The results of the empirical research were conducted to allow the following conclusions to be drawn. The most significant finding of the research is the existence of three, equifinal combinations (C1a, C1b, and C1c) leading to high job satisfaction under digital transformation conditions. The first combination (C1a) is the combination of task characteristics and knowledge characteristics. The second combination (C1b) indicates that knowledge characteristics, social characteristics, and contextual characteristics are sufficient to achieve high job satisfaction. On the other hand, the last, third combination (C1c) requires the presence of task characteristics, knowledge characteristics, and contextual characteristics in the absence of social characteristics for high job satisfaction. Each combination has coverage of between 41% and 47%.

According to the fs/QCA results, the knowledge characteristic present in all three solutions leading to high job satisfaction is an almost always necessary condition with the consistency of 0.91, although other conditions must also be present. This result greatly expands existing knowledge in the field of work characteristics in the conditionality of transformation and digital maturity. Knowledge characteristics reflect the types of knowledge, skills, and ability requirements that are placed on the individual in relation to what is done at work. The first element of this characteristic, job complexity, refers to the difficulty and complexity of the tasks to be performed. It should be emphasized that work that involves complex tasks requires the use of multiple skills at a high level, which is a common phenomenon in the age of digital transformation. The second element of the knowledge characteristics is information processing, which reflects the extent to which the job requires dealing with and processing data or other information. As previous research has shown, the type of work performed affects the level of monitoring and processing of information, that is, some works and tasks require a higher level of monitoring and active processing of information, while others require a lower level [56]. High-level information processing is directly related to Industry 4.0, where it is required by the adaptation of digital solutions and technologies. Another element of knowledge characteristics is problem solving, which refers to diagnosing and solving non-routine problems, creativity in generating unique and innovative ideas and solutions, and preventing or correcting errors. According to Shalley et al. (2000) [57], problem solving is conceptually linked to creativity requirements at work and is a natural extension of information requirements at work. Another is skill variety. Skill variety refers to the individual’s use of a wide variety of skills to bring the job to completion. These elements of the knowledge characteristic are also relevant in the age of digital transformation. The last element of knowledge characteristics is specialization. Specialization reflects the depth of knowledge and skills in a given field, that is, it refers to the degree to which work involves performing specialized tasks or having specialized knowledge and skills. The results of the conducted research indicate that knowledge characteristics are a necessary condition in all three configurations to achieve high job satisfaction. This feature is particularly important in the era of Industry 4.0, where digital solutions and technologies are implemented and widely used. These include, among others: the
internet of things, cyber-physical systems, big data, artificial intelligence, cloud computing, cybersecurity, blockchain, augmented reality, etc. Digital transformation, in a way, forces and requires employees to monitor and process information during the performance of their duties, to be creative in solving problems and to propose unique solutions, to use various, broad skills at work, and to have narrow, specialized skills and knowledge. The constituent elements of knowledge characteristics facilitate meeting the barriers and challenges of the Fourth Industrial Revolution, which in turn helps employees to achieve higher job satisfaction.

It should be emphasized that the relationship between job characteristics and employee job satisfaction has already been the subject of numerous studies and analyses in the literature on the subject. However, the authors have not encountered research conducted in this area in terms of analyzing different combinations of job characteristics that can simultaneously lead to the same level of job satisfaction for employees, especially in an Industry 4.0 environment. Traditional linear or interaction causality models look for a single best solution in which all causal variables compete with other variables in explaining the outcome. However, in reality, conditions such as work characteristics may support rather than compete with each other, leading to a jointly desired outcome [58]. Hence, this study uses fs/QCA, which is a configurational, non-linear, and asymmetric interaction modelling that allows for significant levels of causal complexity in the set relationships [35,36,54,58].

The results of our study therefore significantly broaden the understanding of the issue analyzed while constituting a significant contribution to the scope of research on job satisfaction under conditions of digital transformation. The results of the research using fuzzy/set QCA also confirmed Proposition 1 and Proposition 2, i.e., that job characteristics lead to job satisfaction under Industry 4.0 conditions and that different combinations of task, knowledge, social and contextual characteristics simultaneously lead to job satisfaction under digital transformation conditions. The identified different combinations of job characteristics represent equifinal solutions indicating that, with different initial conditions, the same outcome, i.e., the same level of employee job satisfaction, can be achieved.

It is also worth noting that social characteristics are absent from the third solution (C1c). This finding indicates that regardless of whether social characteristics are high or low if the other three conditions are present, employees will enjoy high job satisfaction. These are the results that constitute the research discovery of the authors of the publication and confirm the previous research, which, however, concerned a more limited scope (for example [32]). It is worth emphasizing that so far the entire combinations of equifinal job characteristics affecting job satisfaction have not been investigated.

In contrast, for the two configurations identified in terms of low job satisfaction, it can be concluded that the combination of the absence of task characteristics, knowledge characteristics, and social characteristics in combination C3 or the absence of social characteristics and contextual characteristics despite the presence of the task characteristics in the C2 combination leads to this result. Each combination has coverage of between 38% and 48%. It should be emphasized that while knowledge characteristics are key to high job satisfaction, they are not significant for low job satisfaction.

Our findings, therefore, provide clear evidence of asymmetric causation: different sets of conditions have been observed for high and low job satisfaction. Importantly, they are not just a reversal of the same conditions. This means that explanations about the presence of high job satisfaction do not automatically provide insight into low job satisfaction. The combinations leading to low job satisfaction differ significantly from those leading to high job satisfaction, both at the level of core and peripheral conditions. This indicates that linear causal methods such as regression-based analysis only provide an insufficient understanding of the complexity of the factors analyzed, i.e., work characteristics in the context of job satisfaction.
6. Conclusions

Small and medium-sized enterprises contribute to economic development, to sustainable development goals, to support sustainable industrialization, and are a source of employment for many segments of society, different sectors, and industries. Market changes resulting from the Fourth Industrial Revolution, the COVID-19 pandemic, and the war in Ukraine are causing small and medium-sized enterprises to operate in an even more turbulent, competitive, and complex environment, and the success of each entity depends to a large extent on the satisfaction of the employees [39]. Job satisfaction is a component of the work environment where conditions and atmosphere are built to encourage high employee participation and commitment to an organization. Therefore, SME managers should recognize and identify the factors that encourage and enable high job satisfaction [60] even more so in this era of digital transformation.

The results of the study have not only helped to fill a gap and develop theory in the area of job satisfaction in SMEs in an Industry 4.0 environment, but also bring important implications for the practice of industrial companies by identifying three different combinations of job characteristics leading to job satisfaction in the Fourth Industrial Revolution. In addition, an important finding of the research conducted using fuzzy-set QCA is the presence of knowledge characteristics as a necessary condition for high job satisfaction in all three combinations. These findings can help build the right work environment and support those work characteristics that contribute most to job satisfaction, especially in the age of digital transformation.

The methodological contribution of this research is to identify complementary features of the set theory approach, fs/QCA, as an appropriate method for examining combinations of work characteristics. The use of fs/QCA allowed the analysis of how the characteristics combine in the context of job satisfaction and therefore provides a tool for dealing with high levels of causal complexity [61].

Despite its various contributions, this study has limitations that should be considered in future research. In particular, work characteristics were analyzed on the basis of surveys completed only by employees without taking into account the views of leaders. This approach may lead to a bias in the interpretation of the results. Therefore, future research should take into account the self-assessment of the leader along with the assessments of employees. Moreover, the research was conducted in a specific context: Polish manufacturing SMEs, operating in the Polish and, to a minimum extent, also in the European market. Therefore, caution should be exercised in generalizing the results to other environments. Future research should extend to other entities as well as to different markets. Moreover, the number of cases was limited. Hence, a more in-depth analysis, based on the results of this study, could more closely examine the impact of work characteristics on job satisfaction in the era of digital transformation. In addition, the study was based on the assessment of work characteristics; however, there are other models relevant to job satisfaction in the literature that may be considered in future studies.

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Appendix A

Measurement items for four dimensions determine the digital maturity.

Culture
1. We believe that our competitive strategy depends on digital
2. Our board and our C-level executives back our digital strategy
3. We have the right leaders to execute on our digital strategy day-to-day
4. We invest in targeted digital education and training at all levels of our organization
5. We clearly communicate our digital vision both internally and externally

Organization
6. We dedicate appropriate resources to digital strategy, governance, and execution
7. The staff supporting our critical digital functions are best in class
8. We have digital skills embedded throughout our organization
9. We have defined and repeatable processes for managing digital programs
10. Our vendor partners deliver value that enhances our digital competencies

Technology
11. Our technology budget is fluid in order to allow for shifting priorities
12. Our marketing and technology resources work together to co-create our digital technology road map
13. We have a flexible, iterative, and collaborative approach to technology development
14. We leverage modern architectures (APIs, cloud, etc.) to promote speed and flexibility
15. We use digital tools to promote employee innovation, collaboration, and mobility

Insights
16. We have clear and quantifiable goals for measuring the success of our digital strategy
17. Every employee understands how her performances ties to corporate digital goals
18. Customer insight actively steers our digital strategy
19. Customer insights inform digital design and development
20. We feed lessons learned from digital programs back into our strategy

Appendix B

Measurement items for job satisfaction and work characteristics (Work Design Questionnaire WDQ).

Job satisfaction
1. I find real enjoyment in my job
2. I like my job better than the average person
3. I am seldom bored with my job
4. I would not consider taking another kind of job
5. Most days I am enthusiastic about my job
6. I feel fairly well satisfied with my job

Work Design Questionnaire
Task Characteristics
7. The job allows me to make my own decisions about how to schedule my work
8. The job allows me to decide on the order in which things are done on the job
9. The job allows me to plan how I do my work
10. The job gives me a chance to use my personal initiative or judgment in carrying out the work
11. The job allows me to make a lot of decisions on my own
12. The job provides me with significant autonomy in making decisions
13. The job allows me to make decisions about what methods I use to complete my work
14. The job gives me considerable opportunity for independence and freedom in how I do the work
15. The job involves a great deal of task variety
16. The job involves doing a number of different things
17. The job requires the performance of a wide range of tasks
18. The job involves performing a variety of tasks
19. The results of my work are likely to significantly affect the lives of other people
20. The job itself is very significant and important in the broader scheme of things
21. The job has a large impact on people outside the organization
22. The work performed on the job has a significant impact on people outside the organization
23. The job involves completing a piece of work that has an obvious beginning and end
24. The job is arranged so that I can do an entire piece of work from beginning to end
25. The job provides me the chance to completely finish the pieces of work I begin
26. The job allows me to complete work I start
27. The work activities themselves provide direct and clear information about the effectiveness (e.g., quality and quantity) of my job performance
28. The job itself provides feedback on my performance
29. The job itself provides me with information about my performance

Knowledge Characteristics

30. The job requires that I only do one task or activity at a time (reverse scored)
31. The tasks on the job are simple and uncomplicated (reverse scored)
32. The job comprises relatively uncomplicated tasks (reverse scored)
33. The job involves performing relatively simple tasks (reverse scored)
34. The job requires me to monitor a great deal of information
35. The job requires that I engage in a large amount of thinking
36. The job requires me to keep track of more than one thing at a time
37. The job requires me to analyze a lot of information
38. The job involves solving problems that have no obvious correct answer
39. The job requires me to be creative
40. The job often involves dealing with problems that I have not encountered before
41. The job requires unique ideas or solutions to problems
42. The job requires a variety of skills
43. The job requires me to utilize a variety of different skills in order to complete the work
44. The job requires me to use a number of complex or high-level skills
45. The job requires the use of a number of skills
46. The job is highly specialized in terms of purpose, tasks, or activities
47. The tools, procedures, materials, and so forth used on this job are highly specialized in terms of purpose
48. The job requires very specialized knowledge and skills
49. The job requires a depth of knowledge and expertise

Social Characteristics

50. I have the opportunity to develop close friendships in my job
51. I have the chance to get to know other people in my job
52. I have the opportunity to meet with others in my work
53. My supervisor is concerned about the welfare of the people that work for him/her
54. People I work with take a personal interest in me
55. People I work with are friendly
56. The job requires me to accomplish my job before others complete their job
57. Other jobs depend directly on my job
58. Unless my job gets done, other jobs cannot be completed
59. The job activities are greatly affected by the work of many different people for its completion
60. My job depends on the work of many different people for its completion
61. My job cannot be done unless others do their work
62. The job requires spending a great deal of time with people outside my organization
63. The job involves interaction with people who are not members of my organization
64. On the job, I frequently communicate with people who do not work for the same organization as I do
65. The job involves a great deal of interaction with people outside my organization
66. I receive a great deal of information from my manager and co-workers about my job performance
67. Other people in the organization, such as managers and co-workers, provide information about the effectiveness (e.g., quality and quantity) of my job performance
68. I receive feedback on my performance from other people in my organization (such as my manager or co-workers)

Contextual Characteristics
69. The seating arrangements on the job are adequate (e.g., ample opportunities to sit, comfortable chairs, good postural support)
70. The workplace allows for all size differences between people in terms of clearance, reach, eye height, leg room, etc.
71. The job involves excessive reaching (reverse scored)
72. The job requires a great deal of muscular endurance
73. The job requires a great deal of muscular strength
74. The job requires a lot of physical effort
75. The workplace is free from excessive noise
76. The climate at the workplace is comfortable in terms of temperature and humidity
77. The job has a low risk of accident
78. The job takes place in an environment free from health hazards (e.g., chemicals, fumes, etc.)
79. The job occurs in a clean environment
80. The job involves the use of a variety of different equipment
81. The job involves the use of complex equipment or technology
82. A lot of time was required to learn the equipment used on the job

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