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Why Manufacturers Need to Engage Employees When Implementing a Smart Factory

A Case Report from the Czech Republic

By focusing on the human element—including communicating the vision and plan to all employees and seeking their thoughts and concerns—manufacturers can make the transition to a smart factory more seamless.

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OVERVIEW: Transformation into a smart factory has a soft side related to people, their motivation, perception, and skills. This study aims to examine staff perceptions about advantages, disadvantages, and barriers that challenge such transformation, and possible supporting measures. Our analysis of a company in a highly competitive manufacturing industry revealed the importance of the human element in the transition to a smart factory. Companies can facilitate the transition by ensuring all employees are aware of and understand the vision and implementation; by engaging with employees to learn about their thoughts and concerns; and by providing opportunities for employees to learn new skills for smart factory jobs. We offer recommendations to help practitioners succeed in transitioning to a smart factory.

KEYWORDS: Smart factory, Digitalization, Employee, Transformation, Supervisor

Changes such as rapid progress in technologies, lack of qualified workers, population aging, or shorter product life cycles, remain in the background of the "smart factory" concept. The smart factory is usually defined as a management system based on robotization, digitalization, big data, the industrial Internet of Things (IoT), and artificial intelligence (AI). It is supposed to increase work productivity (Mařík 2016), flexibility (Balga 2018), and decrease delay time (Balga 2018).

Previous research has focused on the challenges of implementing these technologies (Rub and Bahemia 2019). Our study, however, highlights the human element in smart factory implementation. Staff are essential to the change process and can influence its success. We studied a Czech company owned by a Japanese conglomerate that transformed a factory into a smart factory. The Czech supplier for car manufacturers struggles with high competitiveness and a strong customer influence on production. We highlight employees' ideas regarding the company's vision of a smart factory; their perceptions of barriers to using more technologies; and their concerns about the gradual digitalization, automatization, and robotization in their workplace. Our study contributes to advancing knowledge about digital transformation management. We provide several recommendations for successfully leading the transformation into a smart factory.

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Literature Review

Industry 4.0 embodies smart technologies in manufacturing and industry (Singhal 2021). Shamim, Gang, and Yu (2016) characterize Industry 4.0 as the introduction of cyber-physical systems for production, including, for example, sensors, starters, microcomputer networks, and the involvement of machines in the value chain. The prerequisites of Industry 4.0 are modern information technologies and data analytics (Lee, Bagheri, and Kao 2015; Shariatzadeh et al. 2016), which lead to flexible, self-controlling production systems (Hecklau et al. 2016).

Companies can achieve efficiencies and benefits when they implement robotization, digitalization, and AI in their factories. Converting to a smart factory can help increase competitiveness and productivity (Radziwon et al. 2014); enable highly diverse, customer-tailored, manufacturing; facilitate coordinated production of several different products; and increase the use of machines and reduce the need for inventory (Shamim, Gang, and Yu 2016). The smart factory is also related to Lean manufacturing in that both use decentralized control, aim to increase productivity and flexibility, and ensure a more waste-free process (Buer, Strandhagen, and Chan 2018). Social benefits include enhanced human learning, fairer wage assessments, and higher employee motivation (Herrmann et al. 2014).

Previous studies also highlight challenges related to the smart factory. Implementing a smart factory requires capital expenditure (IIoT World 2021) and reduces significantly the number of manual labor jobs, especially low-skilled work (Špička, Tykva, and Červinka 2016; Bohn et al. 2018). A smart factory requires a more highly skilled workforce (McKinsey&Company 2017; IIoT World 2021) and the need for continuous employee training increases (Shamim, Gang, and Yu 2016; Land 2016; Industry4EU 2015). A smart factory also changes a company's organizational structure by moving away from centralization, rules and formalities, and strict vertical communication and hierarchies of authority (Shamim, Gang, and Yu 2016). As a result, the transition to the smart factory is likely to require a change in leadership style (Prifti et al. 2017; Shamim et al. 2016) to one that promotes autonomy, innovation, and learning (Thomas, Kass, and Davarzani 2014). A smart factory also changes companies' organizational culture (Sivathanu and Pillai 2018).

Transformation into a smart factory is complex. New technologies require tremendous investment (Abdallah, Shehab, and Al-Ashaab 2021). Smart factories can fail due to a lack of human capital or social capital (Bellantuono et al. 2021). Human capital refers to the knowledge, skills, abilities, and mindsets of individuals and teams (Hendriks, Célio, and Sousa 2013; Subramaniam and Youndt 2005). Social capital refers to the knowledge embedded within, available through, and used by interactions among individuals and their networks of interrelationships (Subramaniam and Youndt 2005). One example of a possible human capital barrier concerning employee mindset is their low motivation for the change based on fear of the unknown, lack of information, or threats to status (Proctor and Doukakis 2003). Social capital barriers can include weak ties between staff or between managers and their employees due to conflicts, different interests, and mutual misunderstanding (Bartsch, Ebers, and Maurer 2013).

To overcome staff reluctance to change, managers must define and communicate a clear vision of the change (Bellantuono et al. 2021; Fichter 2019) that is appealing but also signals continuity (Venus, Stam, and van Knippenberg 2018). Communication is a vital way to explain and prepare people for change (Kitchen and Daly 2002). Employees also must be offered training programs (Abdallah, Shehab, and Al-Ashaab 2021).

Researchers have studied transformation into a smart factory, but not enough research exists regarding the soft side (Singhal 2021; Sjödin et al. 2018). They have studied smart factory from the perspective of senior management (Sjödin et al. 2018), but researchers have not explored the perspective of employees at lower levels in the organization (Müller 2019). We opted to focus on employees' ideas regarding the smart factory concept and their perceived barriers related to digitalization, automatization, and robotization in the factory.

The Company

This case study focuses on a Czech company that is part of a Japanese conglomerate comprising 79 firms with more than 42,000 employees worldwide. The conglomerate is active in the automotive sector, and its customers are the most famous car manufacturers. The automotive industry places a huge emphasis on speed, quality, and efficiency. Suppliers must follow and prove they are compliant with quality standards (Levinský 2014). The company we studied in 2019–2020 holds several quality certificates and focuses on cleanliness, work safety, and health protection.

The company has more than 600 workers, and approximately 16 percent are contract workers. The workforce comprises several nationalities: Czech, Slovaks, Hungarians, Japanese, Mongols, and Romanians. The annual rate of employee turnover is around 12 percent. The company has a three-shift system divided into 8 hours each.

In 2012, the company's leadership decided to transform the factory into a smart factory. The company has undergone several stages of this transformation process. This transformation has included implementing a traceability system and a real-time production dashboard; enterprise resource planning; a supervisory control and data acquisition system; development of its own IoT controller; creation of a parametrization scheme for predictive maintenance; automation in production (for instance, a fully automatic trolley for transport, implementation of a fully automatic line). Based on their experience, the company's leadership realized that its people are pivotal to successful transformation.

The company notified its staff in several ways. Initially, 150 employees learned of the smart factory plan at the president's regular monthly presentation. Middle management

received direction to inform their staff members about changes at regular meetings. Senior management has indicated that many employees have already recognized some changes in production and see positive impacts of new technologies. To increase the likelihood of success and decrease the risk of change failure, the company's leadership engaged us to learn how employees perceive the change, including its impacts and barriers, and what measures they recommend senior leadership take.

Based on their experience, the company's leadership realized that its people are pivotal to successful transformation.

Method

Seventeen employees participated in our study. The company's HR department selected the employees based on our suggestions about job positions that could be affected by the smart factory implementation. Eight men and nine women participated. Seven participants were 25–40 years old; ten were over 40 years old. Five participants had vocational training, eight had secondary education, and four had higher education. Fourteen interviewees had worked for the firm for more than 10 years, two for between 6 and 10 years, and one for less than 5 years (Table 1).

We conducted semi-structured interviews. We asked interviewees about the concept of the smart factory and the level at which the company has already fulfilled its vision of the smart factory; their perceived positive and negative impacts on work due to the more intensive use of technologies; perceived barriers concerning using more technologies and gradual digitalization, automation, and robotization within the company; and suggestions regarding what support management can provide to ensure the successful transformation into a smart factory.

We used closed card sorting, a technique used mostly by information architects (Spencer and Warfel 2004) but which is sometimes used in other studies (Phuong et al. 2021; Haldin-Herragard 2016; Matošková et al. 2013). Cards with concepts are prepared in advance and participants sort them according to the instructions. When sorting, participants think aloud and explain their thought processes. The interviewer also encourages the participant to explain why they

TABLE 1. Overview of participants

Participant	Gender	Age (years)	Education	Tenure (years)	Job Position (Category)	Job Position (Group)
R01	Female	41–60	Secondary	>10	Purchasing	Clerical
R02	Female	41–60	Higher education	>10	Senior management	Senior and middle management
R03	Male	25–40	Higher education	2–5	Middle management	Senior and middle management
R04	Female	41–60	Secondary	>10	Production planning and preparation	Clerical
R05	Female	41–60	Secondary	>10	Production planning and preparation	Clerical
R06	Male	41–60	Secondary	>10	Middle management	Senior and middle management
R07	Male	41–60	Vocational training	>10	Production operators	Operators
R08	Male	25–40	Secondary	>10	Foremen and forewomen	Lower management
R09	Female	25–40	Secondary	6–10	Production operators	Operators
R10	Female	41–60	Secondary	>10	Production operators	Operators
R11	Male	41–60	Vocational training	>10	Foremen and forewomen	Lower management
R12	Female	25–40	Secondary	>10	Production planning and preparation	Clerical
R13	Male	25–40	Vocational training	>10	Foremen and forewomen	Low management
R14	Female	25–40	Vocational training	6–10	Production operators	Operators
R15	Female	41–60	Vocational training	>10	Production operators	Operators
R16	Male	41–60	Higher education	>10	Senior management	Senior and middle management
R17	Male	25–40	Higher education	>10	Process engineers	Clerical

TABLE 2. Possible barriers to the smart factory transformation

Possible Barriers of the Smart Factory Transformation Mentioned on Cards
• *Finance barriers:* costs, lack of money, low liquidity of resources, slow return on investments • *Technical and technological barriers:* Unfeasibility, mutual non-compatibility, cybernetic security • *Lack of human capital:* Lack of employees, difficulty filling some job positions, limited knowledge and skills, high employee turnover • *Employees' personal barriers:* Fears and worriers, unwillingness to change, unwillingness to learn, bad experience, laziness, lack of motivation, low satisfaction with job • *Management barriers:* Unclear vision/strategy, leadership style, supervisors' lack of understanding, low engagement of managers, insufficient prediction of change impacts, underestimation of employee fears from change • *Information barriers*: Lack of information, oversaturation with information, communication media used • *Cultural barriers*: Norms and values in the company, differences among cultures, differences in respecting rules and norms, language barriers, prejudices • *Legal barriers*: Limitation and regulation, non-existing legal adjustment, GDPR and personal data protection, the amount of administration • *Time barriers:* Employee workload, lack of time • *Ecological barriers:* The impact on the environment • *Ethical barriers:* Moral values and attitudes, ethical rules • *Market barriers:* Customers, suppliers, competitors, the rate of change • *Organizational barriers:* Used procedures and practices, lack of autonomy, lack of training, lack of easily measurable indicators about the change, bureaucracy, lack of support for the change, high level of stress • *Material barriers:* Lack of materials • *Communication barriers:* Defamations, lack of communication, lack of information about the change, conflicts and their way of solving, style of communication • *Relationship barriers:* Bad human relations, lack of trust, lack of cooperation, bad relations among managers and employees

chose the card. In our case, interviewees sorted them into two groups only: relevant and irrelevant in their company context.

The interviews lasted 30 minutes. Two interviewers participated in each interview. One asked questions and the other wrote notes and distributed and collected cards. Four interviewers participated in total. At the beginning of the interview, the interviewer explained the interview's purpose, and each participant completed an identification sheet, which was then processed separately to ensure their anonymity. Each interviewee received supplementary materials: a definition of a smart factory; a number scale from 0 to 10 to evaluate how much the company has fulfilled the idea of the smart factory; and cards with terms of possible categories of barriers identified by secondary data analysis (Table 2).

We recorded, transcribed, and analyzed all the interviews using Atlas.ti software. We used a line-by-line hybrid coding approach that combined inductive and deductive approaches. Descriptive coding summarized the extracts using a single word or noun that encapsulates the general idea of the data. Two researchers worked on the data analysis; each coded a different set of interviews. They met regularly and discussed suggestions for new codes, possible code merges, and possible code separations. Then they completed structural coding: we grouped the codes into categories and established a hierarchical coding frame.

Results

We present our findings regarding interviewees' ideas about the smart factory; their perceived negative and positive impacts of the technologies on work; their perceived barriers to the transformation into a smart factory; and their suggestions for what could help a successful transformation into the smart factory.

Participants' Ideas about the Smart Factory

Participants discussed their ideas about the smart factory (Table 3). Sixteen of them (94 percent) (from all groups of job positions) indicated that the smart factory means greater automation in the company. For example, R01 said, "I think there is a higher percentage of those devices, and with the introduction of those robots, robotic lines, a person works there more as a system administrator or just watches over it so that it runs and works as it should."

Another common idea expressed (15 participants, 88 percent) was that the smart factory would lead to changes in job characteristics and result in fewer people in production being needed. Low-level managers and employees in non-managerial positions mentioned this idea more often. Low-level managers and staff in clerical positions (3 participants, 18 percent) shared that they expected there will be less work with people. As R11 explained, "I just hope I'm going be less busy with people. Dealing with all their not coming to work, vacations, now you're doing it wrong, and so on . . . that [the future] will cut down on such record keeping."

Seven participants (41 percent), especially low-level managers, have associated the smart factory with higher requirements in terms of employee qualifications. "In our department, the operators work with a tablet and with systems where the operators themselves write the outputs, whereas in the hall only the leaders do it," said R15, who works in the production department, which has a higher level of automation. "We had two girls from the hall come to us, saying they have carpals [carpal tunnel syndrome] and can't work on the hall. They're with us, and they said that, even though it just seems more relaxed at first glance, there's more work to think about, more things to worry about, and more responsibility for getting it right."

TABLE 3. Employee participants' ideas about the smart factory

Code Category/Code	Groundedness of the Code Category/Code				
	Total	Senior and middle management (4)	Low-level management (3)	Clerical (5)	Operators (5)
More Automation	86	**14**	**22**	**34**	**16**
A bigger rate of automation	49	6	9	22	12
The system collects data by itself	9	1	4	4	
Automatic process monitoring	7	1	2	3	1
Implementation of information system	6	3	1	1	1
Automatic data evaluation	5	2	1	1	1
More autonomous movements	3		2	1	
Automatic elimination of rejects	2			2	
Others (automatic evidence of products done, the machine plans material by itself, machines communicate with each other, robots communicate with the central office, more robots)	5x1	1	2	1	1
Changes in Job Task Characteristics	40	**5**	**9**	**13**	**13**
Fewer people are necessary	27	3	6	8	10
Less work with people	6		3	3	
Employee as a system administrator	5	1		1	3
Some job tasks disappear	2	1		1	
Higher Requirements for Employee Qualifications	25	**1**	**17**	**1**	**6**
IT literacy is necessary	5		2	1	2
Language skills are necessary	3		2		1
Creativity is necessary	2	1	1		
A proactive employee approach is necessary	2		2		
Change of requirements on employees	2				2
Others (employees are qualified, necessary: orientation in information, a positive attitude, statistic knowledge, self-reliance, numeric expertise, the ability to solve problems, HR management expertise, management expertise, flexibility, quality management expertise)	11x1		10		1
Impacts on Production and its Monitoring	19	**9**	**2**	**6**	**2**
A very low error rate	5	4		1	
Immediate information about lines	3	1	2		
It is known in which phase the product is	2	2			
A loss of direct relationship with the production	2			2	
Production just-in-time	2	1		1	
Others (tracing back is possible, production visualization, a higher rate of centralization, Lean production, small production)	5x1	1		2	2
Preparation as a Key Part of Production	5	**0**	**2**	**3**	**0**
A bigger emphasis on the phase of production preparation	2			2	
Material and components delivered just-in-time	2		1	1	
All related to the production preparation	1		1		
Bigger Influence of Customers on Production (the customer can influence the production, the customer sees what outputs are, communication with customers is necessary)	3	**0**	**2**	**0**	**1**
Efficient Store (store is minimalized, outsourcing of store management)	2	**0**	**0**	**2**	**0**
Other Ideas (a bigger firm)	1	**0**	**1**	**0**	**0**

Note: Groundedness shows how many times a code category/code has been applied in data coding. Code categories are in bold. To make the table smaller, the codes that appeared only once are grouped together in one row, which is indicated in the "Total" column by an "x," where the number before it indicates how many codes were so grouped and the number after it indicates that each of them appeared only once.

Generally, factory workers are quite informed about the smart factory concept and vision; they associate the smart factory with automation and fewer staff being needed.

Four participants (24 percent) mentioned the link between the smart factory and production preparation; eight participants (47 percent) cited production and its monitoring; and 2 participants (12 percent) indicated storage. Two interviewees (12 percent) indicated they also expect a larger involvement of customers in production. It was primarily those in senior and middle management and clerical positions who see future impacts on production and monitoring it. For example, R08 said, "I understand the smart factory means that the customer, the car company, sees our processes online, sees what the outputs are, sees that there is such a performance on the line."

The interviewees shared their concern that the smart factory means a loss of direct relationship with production. "This is what I think will be the risk in the future, that we will be detached from reality. Earlier, when we needed to find out what efficiency was, we would go to that place and find out. Or we've taken some reports that we've run," R17 said, "but now, maybe too much, we're relying on that automated data collection . . . This is a bit related to the lack of awareness of how it works."

Generally, factory workers are quite informed about the smart factory concept and vision; they associate the smart factory with automation and fewer staff being needed. However, not all employees understood the term "smart factory" correctly: one interviewee guessed that the smart factory means a bigger firm.

After familiarizing themselves with the prepared definition of the smart factory, 11 interviewees (65 percent) judged that their employer was somewhere in the middle of completing the transition to a smart factory. R07, who gave 3 out of 10 possible points, was pessimistic and believed that a long journey was still ahead. By contrast, five interviewees (29 percent) were more optimistic and thought most of the journey was behind them; they evaluated the firm's current level of smart factory implementation at level 7 or 8 out of 10 possible points.

Perceived Positive and Negative Impacts of Technologies on Work

Regarding their expectations of the future, participants were mainly positive and mentioned many benefits of a more intensive implementation of technologies (Table 4).

Of the seventeen interviewees, six (35 percent) responded that they expect easier work, five (29 percent) expect faster accomplishment of activities, and two (12 percent) the possibility to concentrate on more significant job tasks. Six participants (35 percent) mentioned the need for fewer workers. For instance, R11 stated, "Automated robots are being introduced instead of humans, so there is no need for them [humans] anymore." Similarly, R13 said, "I think we're going to replace a lot of operators, hopefully not us managers, with robots." Operators mentioned the positive impact of technologies less often than the other groups of job positions.

Regarding possible negative impacts of technologies on work, five participants (especially clerical employees) indicated that people are still necessary because robots cannot make complex decisions or build relationships with suppliers (Table 5). "There are some things that really have to be decided by a human instead of the system because the system is not capable of handling all those inputs in a way that won't just have some bad impacts on the production and the bottom line of that company. Some things just can't be typed into that system," R01 said.

Interestingly, participants said the smart factory means that results are more visible. "There's no way you can hide . . . it'll be immediately obvious if you do something wrong," explained R02. Similarly, R08 recognized the impact of visibility of results on interactions with customers. "I think from a smart factory perspective there will be a huge push. Now, if there's a screw-up, the customer is said something, somehow it gets worked out," R08 said. "By making it a smart factory, the customer will already see it; it will be more difficult for me to deal with those abnormalities."

We found it particularly interesting to compare perceived negative impacts related to automation across groups of job positions. According to staff in clerical positions and operators, implementing new technologies could be more challenging than managers would expect.

Smart Factory Transformation Barriers

Participants discussed barriers related to the more intensive implementation of new technologies, robotization, and automation (Table 6). Participants mentioned some problems with materials (lack of good-quality materials, unreliable suppliers who do not deliver material in time) and technologies (mutual incompatibility of systems). Not surprisingly, quite often participants (10 participants, 59 percent), chose the necessity of finance investment as a barrier. All participants were aware of the soft side—that is, the human element—of the implementation of a smart factory.

Twelve participants (71 percent) chose the lack of human capital most, followed by the low motivation for the transformation (10 participants, 59 percent). Four interviewees (24 percent) said they understand that qualified staff are necessary for the implementation, and attracting candidates for positions such as design engineers, electro-mechanical and IT specialists is difficult due to a shortage in the labor market. R13 said, "They're [management] having trouble with technicians and specialists right now . . . They're always looking for an automation technician, a specialist, and so

TABLE 4. Perceived positive impacts on work related to the smart factory implementation

Code Category (its frequency of occurrence)/Code	Groundedness of the Code Category/Code				
	Total	Senior and middle management (4)	Low-level management (3)	Clerical (5)	Operators (5)
Job Characteristics (Improved)	**22**	5	5	**10**	2
Easier work	12	1	4	5	2
Concentration on significant activities	6	2		4	
A higher job complexity	1		1		
Less stress	1	1			
Less work	1	1			
More autonomy	1			1	
Work Inputs (Less and Better)	**19**	4	**7**	**7**	1
Fewer people are necessary	11	1	6	4	
Cost reduction	5	2	1	2	
Improvement of orders from customers	1			1	
Material in time	1				1
Shorter waiting time for data from customers	1	1			
Work Outputs (Faster, Better, and Cheaper)	**16**	**7**	5	1	3
Faster accomplishments of activities	7	3	2		2
Decrease in the number of mistakes	3		2	1	
Shorter reaction time	3	3			
Higher productivity	1				1
Cheaper products	1		1		
Faster data for communication with customers	1	1			
Performance Management (Better and Simpler)	**9**	4	2	3	0
Better feedback	2		1	1	
Better monitoring of the processes and the results	2	2			
Simpler evaluation	2		1	1	
Keeping norm	1			1	
Accuracy of information	1	1			
All have the same data	1	1			
Processes (Easier and More Flexible)	**6**	3	3	0	0
Easier planning	3		3		
A possibility to coordinate production	1	1			
Bigger flexibility	1	1			
Simpler processes	1	1			

Note: Groundedness shows how many times a code category/code has been applied in data coding. Code categories are in bold.

on." Study participants also mentioned that mutual relationships within the company might be important for the successful implementation of the smart factory. R03 said, "Sometimes there's a communication problem between people here. There are some personal conflicts between people. It's not even about what to do, but whom to do it with, and it's already a problem." R17 echoed this sentiment: "There's a hunger for quality employees right now. This is definitely a big point, a big topic. Let's say we will reduce the total number of employees in the future with automation, but the demands on individual employees will increase."

The soft side of the smart factory implementation also includes human resource management, the company's vision of the change, and how it communicates information. Two participants said senior management's vision of the smart factory is unrealistic and naïve. "Management has a lack of

TABLE 5. Perceived negative impacts on work related to the smart factory implementation

Code Category/Code	Groundedness of the Code Category/Code				
	Total	Senior and middle management (4)	Low-level management (3)	Clerical (5)	Operators (5)
Human Capital (Missing)	**13**	**3**	**0**	**8**	**2**
People are still necessary	11	1		8	2
Ability to analyze data is necessary	1	1			
More specialists are necessary	1	1			
Job Characteristics (More Demanding and Less Motivational)	**12**	**4**	**3**	**5**	**0**
Bigger cognitive demands of job tasks	2		1	1	
Bigger responsibility for the results	2		1	1	
Higher cooperation with others is necessary	2	2			
Less autonomy	2	1		1	
Less variety of tasks	2		1	1	
Fewer possibilities for informal relationships	1			1	
Lower job complexity	1	1			
Automation (Demanding)	**11**	**1**	**1**	**2**	**7**
Production implementation is more complicated	4	1	1		2
Risk of poor-quality work of the robot	3				3
Repairs of robots take a long time	2				2
Not all products are suitable for bigger automatization	1			1	
Packaging standardization is necessary	1			1	
Performance Management (More Objective)	**4**	**2**	**1**	**1**	**0**
Results are more visible	4	2	1	1	

Note: Groundedness shows how many times a code category/code has been applied in data coding. Code categories are in bold.

TABLE 6. Perceived barriers of the smart factory implementation

Code Category/Code	Groundedness of the Code Category/Code											
	Total	Gender		Age		Education			Group of Job Positions			
		M	F	25–40	>40	T	S	H	O	C	L	S&M
		(8)	(9)	(7)	(10)	(5)	(8)	(4)	(5)	(5)	(3)	(4)
Human Capital	**71**	**49**	**22**	**46**	**25**	**26**	**19**	**26**	**14**	**20**	**18**	**19**
Lack of human capital	27	21	6	17	10	9	7	11	5	9	6	7
Lack of staff motivation for the change	17	9	8	9	8	9	5	3	5	3	6	3
Employee overloading	10	9	1	9	1	1	3	6		4	2	4
Fear of losing a job	6	2	4	3	3	2	2	2	2	4		
Lack of language skills among staff	5	3	2	5		2	1	2	2		1	2
High level of stress	4	4		2	2	2	1	1			2	2
Others (not respecting rules and norms, small engagement of managers)	2x1	1	1	1	1	1		1			1	1
HR Management	**20**	**11**	**9**	**13**	**7**	**4**	**4**	**12**	**2**	**6**	**3**	**9**
Too directive management style	9	4	5	5	4	1		8	1			8
Lack of training and development	5	3	2	3	2	1	2	2		4	1	
Information overloading	3	3		3		1	1	1		1	2	
Others (not the same conditions for all nationalities, unresolved interchangeability of some staff, restructuring is necessary)	3x1	1	2	2	1	1	1	1	1	1		1
Change Vision and Its Communication	**18**	**14**	**4**	**14**	**4**	**7**	**3**	**8**	**5**	**5**	**4**	**4**
Lack of information	11	8	3	10	1	2	2	7	3	4	1	3
Unrealistic vision	3	2	1	2	1	3			1		2	
Unclear vision	2	2			2	1	1		1			1
Lack of prediction of change impacts from managers	2	2		2		1		1		1	1	
Social Capital	**16**	**12**	**4**	**10**	**6**	**8**	**1**	**7**	**2**	**1**	**6**	**7**
Conflicts, envy, and gossip	8	6	2	5	3	5	1	2	2	1	3	2
Lack of information sharing	6	4	2	3	3	1		5			1	5
Others (lack of cooperation, lack of trust)	2x1	2		2		2					2	
Initial Prerequisites	**14**	**6**	**8**	**6**	**8**	3	**8**	3	4	5	3	2
The necessity of finance investment	12	4	8	4	8	3	8	1	4	4	3	1
Legal regulation	2	2		2				2		1		1
Technical, Technological, and Process Issues	**14**	**10**	4	**8**	**6**	**7**	4	3	2	1	**7**	4
Lack of good-quality material	4	3	1	1	3	3	1			1	3	
Much administrative work	4	4		3	1	1	2	1			2	2
Material not in time	3	1	2	3		2	1		2		1	
Others (mutual incompatibility of systems, wrong project documentation, not everything is predictable)	3x1	2	1	1	2	1		2			1	2

Notes. Groundedness shows how many times a code category/code has been applied in data coding. Code categories are in bold. To make the table smaller, the codes that appeared only once are grouped together in one row, which is indicated in the "Total" column by an "x," where the number before it indicates how many codes were so grouped and the number after it indicates that each of them appeared only once.
M = man, F = female, T = trained, S = secondary, H = higher, O = operators, C = clerical staff, L = low-level management, S&M = senior and middle management.

anticipation of the impact of these changes. Maybe they see the fact that there will be a robot, and it will work right away and won't need an operator," said R15. "But it's certainly not like that at first. For example, when a new line is built, it is expected that new pieces will come out of it right away, but it doesn't work that way either. It all has to be tweaked and set up."

Our findings also revealed some differences of opinion about the barriers to implementing the smart factory. Regarding the groundedness, more often male interviewees' mentioned barriers such as lack of human capital, employee overloading, and lack of information. In contrast, female participants often chose financial barriers. Looking at age, people under 40 mentioned employee overload and lack of staff language skills more often. Additionally, participants with higher education mentioned employee overloading and too directive management style more often; secondary educated employees mentioned the need to invest in finance; and employees with vocational training commented on the lack of staff motivation for the change and managers' unrealistic vision more often. These results indicate that participants' gender, experience, and job positions may impact perceived barriers. All groups of job positions understand that there might be some challenges related to staff and their qualifications. Senior and middle managers worry that the current directive management style could be a barrier in the future and they would probably welcome more autonomy and more information sharing.

TABLE 7. Possible supporting measures related to the smart factory implementation

Code Category/Code	Groundedness of the Code Category/Code				
	Total	Senior and middle management (4)	Low-level management (3)	Clerical (5)	Operators (5)
Managing the Change Better	**50**	**13**	**6**	**14**	**17**
Emphasis on people training and development	16	8	1	5	2
Enough information provided	14	1	2	4	7
Support from the supervisor	12	1	2	4	5
A possibility to experiment	2				2
Solving problems in time	2	1	1		
A possibility to suggest an improvement	1			1	
An advisor offered	1				1
Leading by example	1	1			
Motivating of subordinates	1	1			
Change Planning Improved	**21**	**10**	**6**	3	2
An elaborated vision	6	1	1	2	2
More people participated	5	3	2		
Enough time for project realization	3		2	1	
Making some processes easier	2	2			
Observing trends	1	1			
Assigned time for learning	1	1			
More money	1		1		
Better software provided	1	1			
Higher rate of activities' automatization	1	1			
Human and Social Capital Procured	**17**	**3**	**5**	**6**	**3**
Collaboration among people	5		1	3	1
Employees' openness to the change	5	2		1	2
A shared vision among employees	2		2		
Cooperating IT department	2			2	
Qualified people procured	2		2		
Higher rate of colleagues' engagement	1	1			
First Steps of the Change Communicated	**7**	**0**	**4**	**3**	**0**
Top management supports the idea of SF	6		4	2	
Increasing awareness of employees about SF	1			1	
Initial Prerequisites Fulfilled	**2**	**0**	**1**	**0**	**1**
Getting the right data	1				1
Perfect suppliers	1		1		
The Progress of the Change Visualized	**1**	**0**	**0**	**1**	**0**
Seeing partial improvements	1			1	

Note: Groundedness shows how many times a code category/code has been applied in data coding. Code categories are in bold.

Suggestions Regarding Achieving a Successful Smart Factory Transformation

We asked participants what management or their colleagues should do to make the transition to the smart factory easier for them and the company (Table 7). Most often, participants said they would welcome more training (8 participants, 47 percent), more information (10 out of 17, 59 percent), and supervisors' support (7 participants, 41 percent). R04 said, "Maybe it wouldn't be a bad idea for the employer to explain to these people how it's going to work and all that. And maybe even explain to them that they're not going to lose their jobs, that they're going to do something else." "I would dearly like everything to be well communicated and dealt with right away, and communication is what I would expect and demand from my boss. Direct, clear communication," said R08. R14 explained she would like her supervisor "to listen properly to what we are asking him to do. And not just: Yeah, I know. He listens to half of it, I don't finish a sentence, and he's gone."

Discussion

Several reports have discussed the hard side—technical and technological issues—of the transformation into a smart factory. Little research exists about the soft side—that is, issues regarding employees' expectations, beliefs, and attitudes. Our study explored employees' perceptions about a factory that has started the transformation process into a smart factory.

Employees' ideas about the smart factory—An encouraging finding was that almost all participants (16, 94 percent) demonstrated basic knowledge of what a smart factory is, likely due to the fact that senior management has presented its vision to employees and the company president often talks about it. Previous studies (Manning 2012; Bertoldi et al. 2018) have recognized leadership vision as an essential element in change management. Also, most study participants have worked for the company for more than 10 years, which means they probably can see greater use of automation in production through time, and connect senior management's vision with their daily experience and changes that have already happened. They can probably see some positive effects in their job—for example, less routine and laborious tasks—which could also explain why participating employees were rather optimistic about the change. Regarding the future, interviewees' expectations that new technologies will eliminate physically strenuous and routine jobs and work aligns with predictions of other studies (Národní vzdělávací fond 2017).

Perceived positive and negative impacts of the more intensive use of technologies—Study participants often mentioned that the employer would need fewer people, which they considered a positive impact. This reduction in the workforce is quite possible. Some other studies expect that digitalization will affect the need for low-skilled jobs in particular (Národní vzdělávací fond 2017; McKinsey&Company 2017). As for technological weaknesses, five study participants (29 percent) said the employer will still need some people because machines cannot do everything. This finding is consistent with previous research, which expects some staff will still be needed and new job positions will appear, but that skills required will be higher in some cases (McKinsey&Company 2017; Land 2016).

Perceived barriers that could complicate the smart factory transformation—Employees pointed out barriers related to initial prerequisites; technical, technological, and process issues; human capital; social capital; vision of the change and its communication; and human resource management. Previous studies support these identified barriers. According to Industry4EU (2015), replacing work with technology is associated with the need for financial investment. Industry4EU (2015) and Kříž (2017) cite the lack of the necessary materials and availability of the required software and hardware, insufficient R&D of technologies, technological infrastructure, interconnectivity, and cloud solutions. Frey and Osborne (2013) suggest that the future could bring a partial replacement of highly qualified work activities associated with creativity and social intelligence. A higher degree of analytical abilities, language skills, computer literacy, and digital maturity is expected (Kohout and Palíšková 2017; Marcon et al. 2019). Employees may refuse to obey the robot's orders and collaborate with them (Kohout and Palíšková 2017), which is often accompanied by insecurity and fear (Lu et al. 2022). Knížek (2019) and Müller (2019) suggest in many cases the vision might be set, but senior management fails to prepare a follow-up strategy and employees lack time for activities related to the change due to their existing responsibilities.

Employee suggestions regarding what could facilitate the transformation for them and the company—Our findings indicate that the company management may have underestimated the role of direct supervisors as mediators of the transformation to a smart factory. Five participants (29 percent) who were not directly involved in vision implementation and who are lower in the organizational hierarchy shared that they lacked information and understanding of what managers needed from them, and 10 participants (59 percent) recommended management to communicate more. Five interviewees (29 percent) expressed concerns about losing their jobs, and seven participants (41 percent) would welcome more support from their supervisors in this transformation process. Previous research has shown that the leadership style of employees' immediate supervisor directly influences those employees' emotions, attitudes, motivation, and behavior (Rahman et al. 2015; Wu and Lee 2017). Supervisors should communicate clearly and effectively with their direct reports about the nature of the change and what will be gained (Manning 2012). Such communication will help employees understand the reasons for change and thereby decrease ambiguity and uncertainty (Proctor and Doukakis 2003). Supervisors must have enough information and communication skills to serve in the roles of communicator and change agent effectively.

We prepared a detailed report and presented our findings to the company's leadership. Based on the results, the

Senior leadership needs to ensure employees receive training and development in digital literacy, creativity, soft skills, and complex thinking.

company's HR department focused more efforts to improve the communication and vocational skills of line managers, foremen, and operators. For example, the company offered several trainings in communication, motivation, and working with the technologies. The company's HR manager shared that the study results helped the company realize the HR department has a pivotal role in the transformation. Going forward, the HR department planned to focus on continuous improvement of employees' communication skills and upgrading their technical skills so they can acclimate to the technical side of smart factory implementation.

Practical Implications

The transformation to a smart factory requires managing the change, including the human component. Senior leadership needs to ensure employees receive training and development in digital literacy, creativity, soft skills, and complex thinking. Employees need dedicated time within their job to learn these skills.

Ongoing communication that permeates the entire company is also key. While senior management may believe it is providing enough information, our interviews revealed some fears and doubts regarding the transformation. Thus, the most critical conclusion emerging from the analysis is: communicate, communicate, communicate. Employees who are not in leadership roles require enough information about the transformation and need to feel that management at all levels is open to and considers their needs and concerns. Companies should consider creating a communication plan that establishes guidelines for communication about smart factory transformation, including who informs whom, when, how, and about what. Meeting with low-level managers and non-managerial workers aimed at exploring and clarifying any employees' misconceptions about the smart factory and leadership's vision would prove beneficial.

Companies need to cultivate a culture of trust so that during the change process, employees can trust that supervisors care about them (Proctor and Doukakis 2003). All managers should be trained in managing competencies to understand the importance of communication, active listening, and feedback. They should be able to explain the senior management's vision in simple terms. If employees understand the nature of and need for the transformation as well as benefits they will realize in their own jobs, their motivation for the change will be greater. Employees involved in implementing the change should have enough time to test their ideas. Too many tasks may leave employees feeling overwhelmed, which could affect their motivation and the quality of their work.

Research Limits and Future Research

A case study has some limitations in terms of generalization. The research sample was quite small, so there may be limitations in terms of general application. Our study confirms the importance of the soft side—that is, the human element—involved in the transformation into a smart factory. Supervisors need proper training to explain the change and its impact so that employees understand the overall benefits and specific implications for their jobs.

It would be worthwhile to pursue further research about the soft aspects of the transformation into a smart factory. Future research could consider how to prepare low-level management for their role in the transformation as well as what is the optimal leadership style for leading more qualified staff. In this context, exploring the active role of the HR department as a partner in implementing such a transformation is crucial and merits study.

Conclusion

Our study focused on employees' perceptions related to the implementation of a smart factory. It revealed that to ensure a successful transformation from a conventional factory into a smart factory with new technologies, digitization, and automation requires a focus on soft skills. Employees' perceptions, attitudes, concerns, and ideas are integral to a successful transformation. Companies can do several things in smart factory transformations: ensure seamless communication of vision and implementation plans through all levels of the organization; engage with all employees to capture their perceptions of barriers and opportunities, and concerns about the impact on their job; and ensure employees can take advantage of opportunities to learn new skills needed for smart factory jobs. Our recommendations can help practitioners in such settings be more successful.

References

Abdallah, Y. O., Shehab, E., and Al-Ashaab, A. 2021. Digital transformation challenges in the manufacturing industry. *Advances in Manufacturing Technology XXXIV*, 9–14. Amsterdam: IOS Press. doi: 10.3233/ATDE210004

Balga, B. 2018. SMART factory – Inteligentní Továrna – IPA Czech. IPA more than expected. https://www.ipaslovakia.sk/clanok/smart-factory-inteligentni-tovarna

Bartsch, V., Ebers, M., and Maurer, I. 2013. Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management* 31(2): 239–51. doi: 10.1016/j.ijproman.2012.06.009

Bellantuono, N., Nuzzi, A., Pontrandolfo, P., and Scozzi, B. 2021. Digital transformation models for the I4.0 transition: Lessons from the change management literature. *Sustainability* 13(23): 12941. doi: 10.3390/su132312941

Bertoldi, B., Giachino, C., Rossotto, C., and Bitbol-Saba, N. 2018. The role of a knowledge leader in a changing organizational environment. A conceptual framework drawn by an analysis of four large companies. *Journal of Knowledge Management* 22(3): 587–602. doi: 10.1108/JKM-09-2017-0422

Bohn, N. U., Pedersen, B., Probst, L., and Verzijl, D. 2018. *Skills for smart industrial specialisation and digital transformation: Interim report*. Luxembourg: Publications Office of the European Union. http://publications.europa.eu/publication/manifestation_identifier/PUB_EANA29359ENN

Buer, S-V., Strandhagen, J. O., and Chan, F. T. S. 2018. The link between Industry 4.0 and lean manufacturing: mapping current research and establishing a research agenda. *International Journal of Production Research* 56(8): 2924–2940. doi: 10.1080/00207543.2018.1442945

Fichter, A. 2019. Change management towards digitalization and innovation. In *2019 17th International Conference on Emerging ELearning Technologies and Applications (ICETA)*, 185–90. doi: 10.1109/ICETA48886.2019.9040141

Frey, C. B., and Osborne, M. A. 2013. The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change* 114: 254–280. doi: 10.1016/j.techfore.2016.08.019

Haldin-Herragard, T. 2016. Mapping tacit knowledge with "epitomes." *Systèmes d'Information et Management* 8(2): Article 5. https://aisel.aisnet.org/sim/vol8/iss2/5

Hecklau, F., Galeitzke, M., Flachs, S., and Kohl, H. 2016. Holistic approach for human resource management in Industry 4.0. *Procedia CIRP* 54: 1–6. doi: 10.1016/j.procir.2016.05.102

Hendriks, P. H. J., Célio, A., and Sousa, A. 2013. Rethinking the liaisons between intellectual capital management and knowledge management. *Journal of Information Science* 39(2): 270–285. doi: 10.1177/0165551512463995

Herrmann, C., Schmidt, C., Kurle, D., Blume, S., and Thiede, S. 2014. Sustainability in manufacturing and factories of the future. *International Journal of Precision Engineering and Manufacturing-Green Technology* 1(4): 283–292. doi: 10.1007/s40684-014-0034-z

IIoT World. 2021. Five challenges of digital transformation in manufacturing. https://www.iiot-world.com/industrial-iot/connected-industry/five-challenges-of-digital-transformation-in-manufacturing/

Industry4EU. 2015. Industry 4.0 for the future of manufacturing in the EU: Final report. VP/2015/001. http://adapt.it/Industry4EU/INDUSTRY%204EU_final_report.pdf

Kitchen, P. J., and Daly, F. 2002. Internal communication during change management. *Corporate Communications: An International Journal* 7(1): 46–53. doi: 10.1108/13563280210416035

Knížek, M. 2019. Digitalizace ve firmách naráží na nekoncepčnost. *Hospodářské Noviny*, October 7. https://ihned.cz/c1-66654210-digitalizace-ve-firmach-narazi-na-nekoncepcnost

Kohout, P., and Palíšková, M. 2017. Dopady digitalizace na zaměstnanost a sociální zabezpečení zaměstnanců. http://ipodpora.odbory.info/soubory/dms/wysiwyg_uploads/bba5a5c7366cdaf3/uploads/Studie_Dopady_digitalizace.docx

Kříž, L. 2017. Hledá se byznys pro internet věcí. *ICT Revue*, May 16.https://ictrevue.ihned.cz/c3-65730930-0ICT00_d-65730930-hleda-se-byznys-pro-internet-veci

Land, S. 2016. Jobs for work 4.0–The future of employment. University of Minho. https://www.wissenschaftsinitiative.at/jobs-for-work-4-0-the-future-of-employment/

Lee, J., Bagheri, B., and Kao, H-A. 2015. A cyber-physical systems architecture for industry 4.0-based manufacturing systems. *Manufacturing Letters* 3:18–23. doi: 10.1016/j.mfglet.2014.12.001

Levinský, A. 2014. Specifik IT v automobilovém průmyslu. *SystemOnLine*, 5. https://www.systemonline.cz/automotive-it-pro-automobilovy-prumysl/specifika-it-v-automobilovem-prumyslu.htm

Lu, L., Xie, Z., Wang, H., Li, L., and Xu, X. 2022. Mental stress and safety awareness during human-robot collaboration – review. *Applied Ergonomics* 105 (November): 103832. doi: 10.1016/j.apergo.2022.103832

Manning, T. 2012. Managing change in hard times. *Industrial and Commercial Training* 44(5): 259–267. doi: 10.1108/00197851211244997

Marcon, É., Marcon, A., Le Dain, M-A., Ayala, N. F., Frank, A. G., and Matthieu, J. 2019. Barriers for the digitalization of servitization. *IProcedia CIRP* 83:254–259. doi: 10.1016/j.procir.2019.03.129

Mařík, V. 2016. *Průmysl 4.0: výzva pro Českou republiku*. 1st ed. Praha: Management Press.

Matošková, J., Řeháčková, H., Sobotková, E., Polčáková, M., Jurásek, M., Gregar, A., and Švec, V. 2013. Facilitating leader tacit knowledge acquisition. *Journal of Competitiveness* 5(1): 3–13. doi: 10.7441/joc.2013.01.01

McKinsey&Company. 2017. *A Future That Works: Automation, Employment, and Productivity*. McKinsey Global Institute. https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Full-report.ashx

Müller, J. M. 2019. Assessing the barriers to industry 4.0 implementation from a workers' perspective. *IFAC-PapersOnLine* 52(13): 2189–2194. doi: 10.1016/j.ifacol.2019.11.530

Národní vzdělávací fond. 2017. *Dopady Průmyslu 4.0 Na Trh Práce v ČR*. http://www.nvf.cz/cms/assets/docs/88ffb3e9f7da58fefd9741bca08796a3/794-0/dopady-prumyslu-4.0-na-trh-prace-v-cr.pdf

Phuong, J., Bandaragoda, C. J., Haldar, S., Stephens, K. A., Ordonez, P., Mooney, S. D., and Hartzler, A. L. 2021. Information needs and priority use cases of population health researchers to improve preparedness for future hurricanes and floods. *Journal of the American Medical Informatics Association* 28(2): 249–260. doi: 10.1093/jamia/ocaa195

Prifti, L., Knigge, M., Kienegger, H., and Krcmar, H. 2017. A competency model for Industrie 4.0 employees. In *Proceedings Der 13. Internationalen Tagung Wirtschaftsinformatik (WI 2017)*, 46–60. St. Gallen, Switzerland.

Proctor, T., and Doukakis, I. 2003. Change management: The role of internal communication and employee development. *Corporate Communications: An International Journal* 8(4): 268–277. doi: 10.1108/13563280310506430

Radziwon, A., Bilberg, A., Bogers, M., and Madsen, E. S. 2014. The smart factory: Exploring adaptive and flexible manufacturing solutions. *Procedia Engineering* 69:1184–1190. doi: 10.1016/j.proeng.2014.03.108

Rahman, M. S., Osman-Gani, A. M., Momen, M. A., and Islam, N. 2015. Testing knowledge sharing effectiveness: Trust, motivation, leadership style, workplace spirituality and social network embedded model. *Management and Marketing* 10(4): 284–303. doi: 10.1515/mmcks-2015-0019

Rub, J., and Bahemia, H. 2019. A review of the literature on smart factory implementation. In *2019 IEEE International Conference on Engineering, Technology and Innovation*. New York: IEEE. https://ieeexplore.ieee.org/document/8792577

Shamim, S., Gang, S., and Yu, H. 2016. Influencers of information system usage among employees for knowledge creation. A future research agenda. In *10th International Conference on Software, Knowledge, Information Management Applications*, 134–141. doi: 10.1109/SKIMA.2016.7916210

Shariatzadeh, N., Lundholm, T., Lindberg, L., and Sivard, G. 2016. Integration of digital factory with smart factory based on internet of things. *Procedia CIRP* 50:512–517. doi: 10.1016/j.procir.2016.05.050

Singhal, N. 2021. An empirical investigation of industry 4.0 preparedness in India. *Vision: The Journal of Business Perspective* 25(3): 300–311. doi: 10.1177/0972262920950066

Sivathanu, B., and Pillai, R. 2018. Smart HR 4.0 – how industry 4.0 is disrupting HR. *Human Resource Management International Digest* 26(4): 7–11. doi: 10.1108/HRMID-04-2018-0059

Sjödin, D. R., Parida, V., Leksell, M., and Petrovic, A. 2018. Smart factory implementation and process innovation: A preliminary maturity model for leveraging digitalization in manufacturing. *Research-Technology Management* 61(5): 22–31. doi: 10.1080/08956308.2018.1471277

Spencer, D., and Warfel, T. 2004. Card sorting: A definitive guide. *Boxes and Arrows*, April 7. https://boxesandarrows.com/card-sorting-a-definitive-guide/

Špička, J., Tykva, T., and Červinka, M. 2016. Průmysl 4.0: Příležitost nebo hrozba? In *Sborník Přednášek z 53. Slévárenských Dnů, Blok E – Sekce Ekonomická*, 10. Brno: Česká slévárenská společnost.

Subramaniam, M., and Youndt, M. A. 2005. The influence of intellectual capital on the types of innovative capabilities. *The Academy of Management Journal* 48(3): 450–463. http://www.jstor.org/stable/20159670 10.5465/amj.2005.17407911

Thomas, R. J., Kass, A., and Davarzani, L. 2014. *From Looking Digital to Being Digital: The Impact of Technology on the Future of Work*. Accenture.

Venus, M., Stam, D., and van Knippenberg, D. 2018. Research: To get people to embrace change, emphasize what will stay the same. *Harvard Business Review*, August 15. https://hbr.org/2018/08/research-to-get-people-to-embrace-change-emphasize-what-will-stay-the-same

Wu, W-L., and Lee, Y-C. 2017. Empowering group leaders encourages knowledge sharing: Integrating the social exchange theory and positive organizational behavior perspective. *Journal of Knowledge Management* 21(2): 474–491. doi: 10.1108/JKM-08-2016-0318

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