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The degree of organisation as a factor influencing the introduction of I4.0

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Abstract

The SME sector is the engine of the Hungarian manufacturing industry, and its development is a central issue. The digitisation "compulsion" is present in society and industrial production. With this in mind, the customised application of Industry 4.0 solutions can become the driving force behind company development. Recently, industrial production has had to confront the pandemic, the war and the consequent energy crisis.

The present study summarises the detailed development plans created during the Hungarian GINOP 1.1.3 research project. It also concludes and establishes hypotheses from the data and information contained therein. We thank IVSZ (The Association of IT Companies) for consenting to our data analysis.

One hypothesis the present study proposes is that from the perspective of Industry 4.0 implementation for companies, the degree of organisation is more important than industry affiliation.

Keywords: Industry 4.0; Manufacturing industry; Hungarian SMEs; Digitisation opportunities; Digital transformation

1. Introduction

The present research and 2019 development project aim to support development grants related to the industrial digitalisation of the Hungarian SME sector (Industry 4.0) with a knowledge base.

I will summarise the initial research results with my co-authors [8], in which we formulate the expected results. Based on a survey of 12 Hungarian production sector companies participating in the project, we established the following hypotheses concerning the progress of the introduction of SME Industry 4.0:

- Progress in introducing Industry 4.0 on the part of Hungarian SMEs is relatively low but rapidly expanding.
- Hungarian SMEs favour some Industry 4.0 solutions.
- Many factors influence the timing and introduction of Industry 4.0. These include: net sales, number of employees, industry segment, geographical layout, degree of organisation.
- Company size increases (employee numbers) are associated with organisation increases. These increases will have the highest impact on the progress of Industry 4.0 implementation [1].

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2. Material and methods

The GINOP 1.1.3 project mentioned in the introduction was created in several steps; this is the so-called customer journey, which aims at the "journey" that SMEs, armed with appropriate process organisation knowledge, must ensure to make well-founded decisions regarding their Industry 4.0 investments.

In the demonstration phase of the GINOP 1.1.3 project, SMEs could acquire process organisation knowledge at well-functioning Model Companies. Based on the acquired knowledge, SMEs were able to create an SDP (Simplified Development Plan).

From the SDP results, we prepared the so-called DDP (Detailed Development Plan) documents.

Both documents follow A3 logic, a structured problem-solving method that presents and solves problems visually. The following table compares classic problem-solving methods:

Key Elements	Problem Solving Approaches				
	8 Disciplines (8D) ***Standard***	**Traditional A3 Report**	**5 Whys**	**Root Cause Analysis (RCA)**	**Problem Analysis Flowchart (PAF)**
	1. Team (f)				
		1. Background (d)			
	2. Clarify the problem (g)	2. Current condition (d)		1. Define the problem (a)	1. Problem statement (a)
				2. Collect the data (a)	
				3. Identify possible causal factors (a)	
		3. Future goal (b)			
	3. Containment (a)				
	4. Identify the root cause (c)	4. Root-cause analysis (c)	5 Why (d)	4. Identify the root cause (a)	2. Symptoms (b)
					3. Changes (b)
					4. Relevant data (b)
					5. Defect free configurations (b)
					6. Distinction (b)
					7. Causal chains (g)
					8. Test, corrections, results and conclusion (f)
					9. Most probable cause (b)
	5. Proposed solutions (f)	5. Countermeasures (f)		5. Recommend and implement solutions	10. Short term and long term corrections and controls (b)
	6. Implement permanent solutions (a)	6. Implementation plan (f)			
	7. Prevent recurrence (f)				
	8. Congratulate the team (Validation) (f)	7. Follow-up action (f)			
	a = text b = bullet	c = diagram d = combination		e = graph f = table	g = sketch

a = text, c = diagram, e = graph, g = sketch, b = bullet, d = combination, f = table

Figure 1 Comparison of problem-solving methods [2]

The 8D report in the first column is a classic problem-solving tool, used most often in the event of a specific quality defect. Moreover, the A3 method offers a comprehensive analysis and conclusion. These can be utilised to proceed with sufficient thoroughness in the event of a complex problem, such as exploring development potential.

To understand the A3 logic, see Figure 2.

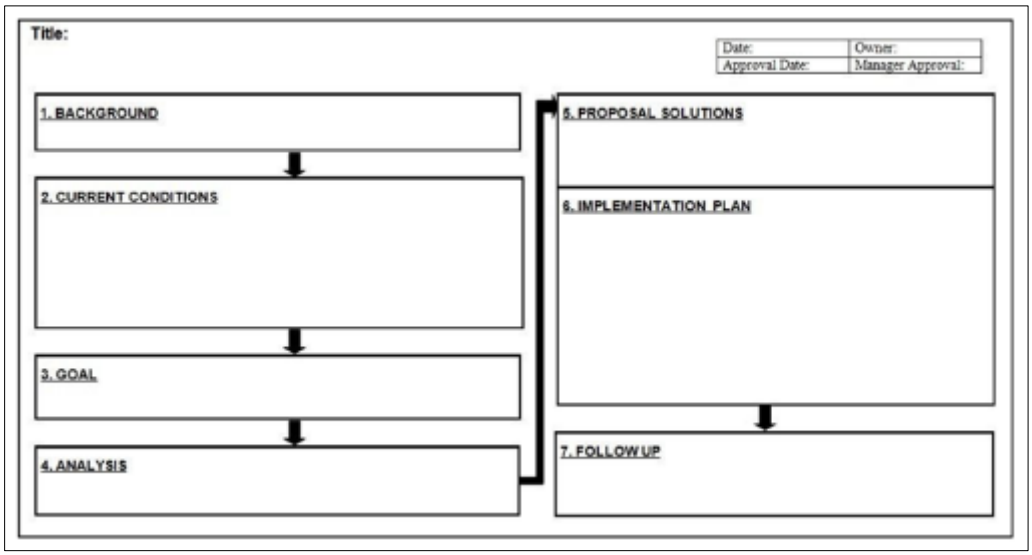

Figure 2 A3 Thinking Template [3]

Nevertheless, the tool required modification to achieve the comprehensive analysis needed to examine the enterprises. An in-depth interview discussion and a specific viewing and observation of the process were necessary to uncover hidden problems. The adaptation of A3 logic was a central issue in the success of the research.

To properly compare the companies, we requested the following basic information:

- Number of employees
- Net income
- Industrial segment
- Geographical location (All enterprises are Hungarian; Budapest and its surrounding area are excluded from the project scope)
- Industry 4.0 progress: a separate indicator (refer to the article) showing the progress of a company's introduction of Industry 4.0 tools as a percentage
- Elaboration of the processes, i.e. degree of organisation: this indicator is also our own creation; it ranks companies on a scale from 1 to 5

According to the degree of organisation, the employee limit is 50 people. Moreover, companies inevitably devote resources to organisation management, department creation, and task assignment. In many countries, legal changes may arise once an SME reaches 50 employees [5]. Hungary classifies companies with between 50 and 250 employees as SMEs.

3. Results and discussion

The hypothesis for the level of organisation was as follows:

The level of organisation, i.e. the elaboration of the processes, has the greatest impact on the progress of introducing Industry 4.0 [6].

To prove this, we have introduced our own indicators:

The degree of organisation is our own indicator, introduced to assess the sophistication of a company's processes. We evaluated the selected companies on a scale of 1–5.

- Initial: controlled, low-level reactive behaviour – attempts at reacting to environmental changes.
- Managed: project-based operation; often reactive behaviour.
- Defined: organisational level operation; proactive nature. Individual projects customise organisational processes.
- Numerically managed: continuously measured, evaluated and controlled processes.

- Optimised: the focus is on continuous process optimisation [7].

Figure 3 shows the organisational concept values, i.e. the numerical values classified by SME.

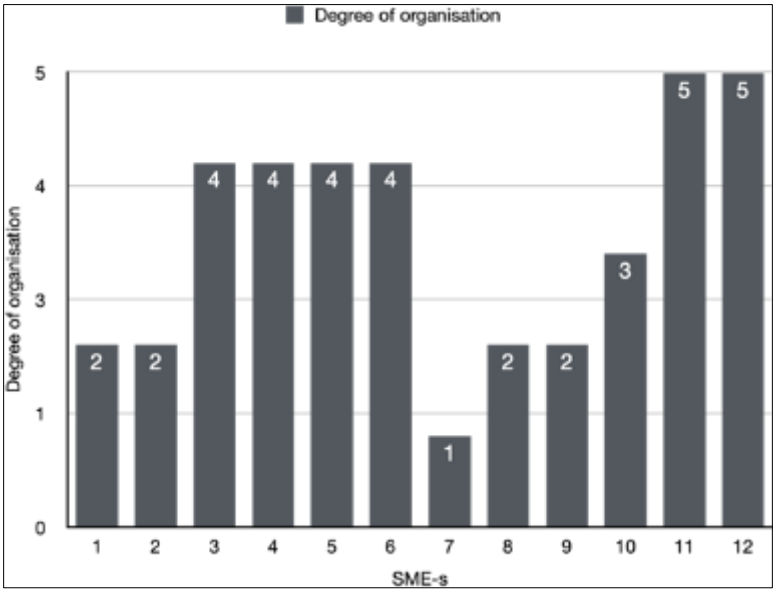

Figure 3 Degree of organisation

3.1. Industry 4.0 progress

This indicator presents the forward movement of Industry 4.0 implementation of the enterprise as a percentage. This percentage comes from measurement points:

- A fully-implemented Industry 4.0 segment is worth 3 points.
- A partly-implemented Industry 4.0 segment is worth 2 points.
- A planned (within two years) Industry 4.0 segment is worth 1 point.
- An unimplemented and unplanned segment is worth 0 points.

Figure 4 displays the I4.0 results of the examined enterprises:

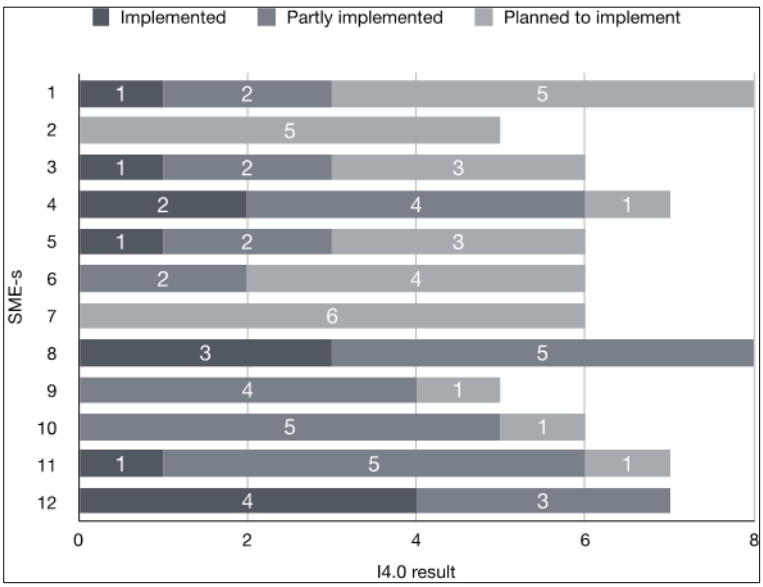

Figure 4 I4.0 results

In the interest of comparability, both indicators were expressed as %. For the degree of organisation indicator, the maximum score of 5 equals 100%, while 0 is 0%.

In Industry 4.0 development, the % value is achieved by dividing the obtained score by the maximum score. The maximum score for the nine dimensions is 9.

Figure 5 exhibits the relationship between the two parameters:

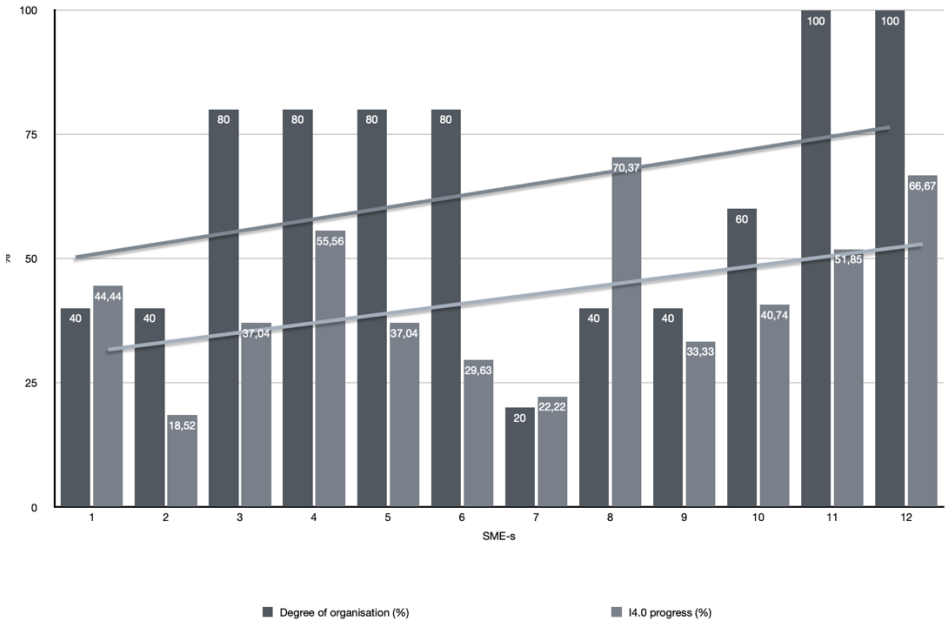

Figure 5 The correlation between the degree of organisation and the I4.0 level

Personal conversations are essential to analyse the Figure 5 data. The figure presents the relationship but glaring exceptions are present. One example is Enterprise 8, which still operates in an extremely unorganised manner, but is nonetheless in an innovative phase due to a successful generational change. Enterprise 3 offers a counter-example. This company is a large SME that has engaged in organisation for many years but has not solved the generational change or responded innovatively to the impacts of the pandemic.

The context and connection that generated the hypothesis can be interpreted in the following way.

Consider the comparison of I4.0 level and industries with the addition of the hypothesis on organisation. Given that the degree of organisation is related to firm size, we have plotted the I4.0 level as a function of this in Figure 6.

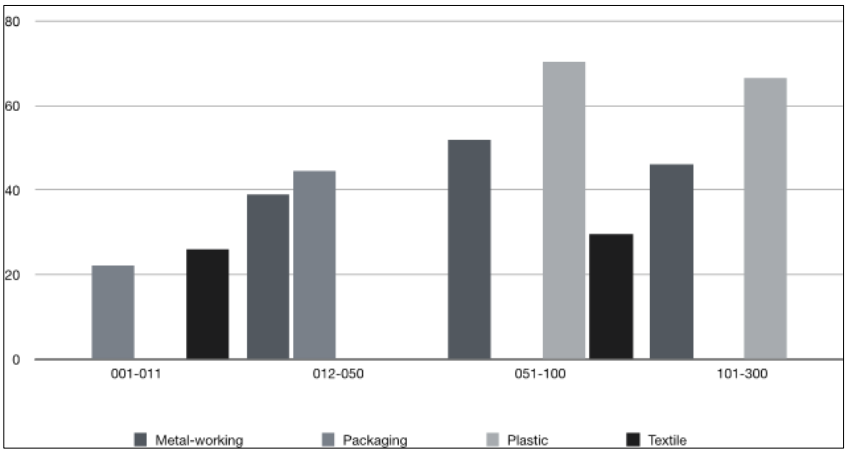

Figure 6 The relationship between I4.0 level and company size

The Industry 4.0 development opportunities are not industry-specific; no significant difference in preparedness between the examined industry groups occurs.

Figure 7 shows the BCG (Boston Consulting Group) survey concerning the results that LEAN brings and the results Industry 4.0 technological developments bring.

During the research work, we began with the assumption that higher development levels of the processes lead to the higher effective application of the individual Industry 4.0 development tools. The research established that LEAN is not an Industry 4.0 solution; however, its interdependence accelerates the development pace within companies.

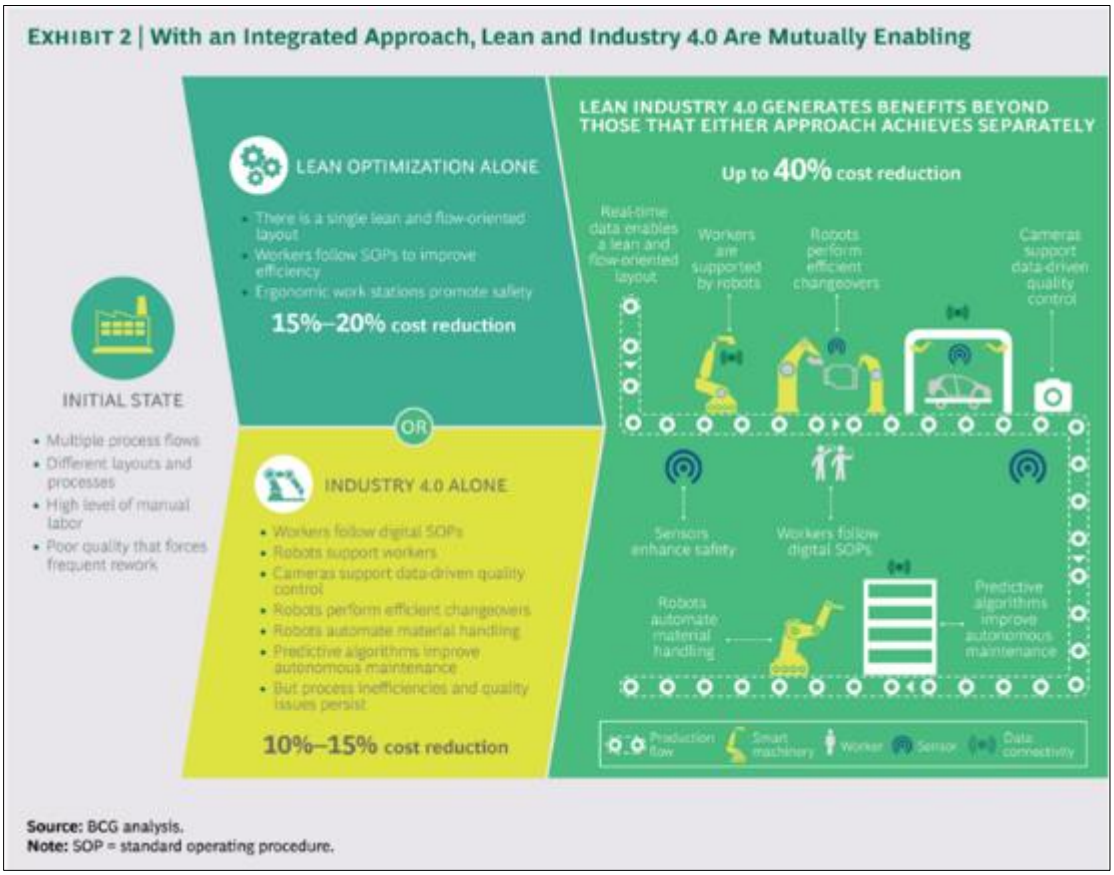

Figure 7 The relationship between Lean and I4.0 [4]

4. Conclusion

The present research study did not cover all possible influencing factors, such as company missions, management style, company culture, etc. Therefore, we recommend further analysis in these areas.

In summary, we can state that many factors influence the progress of introducing Industry 4.0. Moreover, enterprise capabilities are also decisive for these processes. One such capability is the degree of organisation we have introduced, i.e. process elaborateness is an indicator. The present study compared these results with the Industry 4.0 progress indicator, calculated from the solutions SMEs implemented or planned.

The tendency of Hungarian SMEs towards Industry 4.0 solutions is remarkably and quantifiably clear.

The further development of the established indicators may even enable comparisons between countries in the given topic.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

Both authors declare that they have no competing interests

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