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Investigating And Ranking the Main Barriers and Enablers of Digital Leadership in The Manufacturing Industry of UK: A Case Study

Abstract

The importance of digital leadership can be traced to the implementation of digital transformation within a business or an organization, alongside the process of digitizing the work environment and learning cultures. As various organisations are finding it difficult to transition due to traditional leadership processes, despite the growing adoption of digital leadership in industries; it is essential to explore the value of digital leadership as well as some of the factors that might be causing a hindrance. The research question is defined specifically to examine the benefits and limitations of digital leadership as defined by various level managers in the work environment, hence this study will specifically identify, investigate and rank the main barriers and enablers of digital leadership in the manufacturing industries.

Using a quantitative methodology, the study analysis centres mostly on numbers and tries to gather a range of numeric data that can be used to learn about a particular group of people, known as a sample population. The Fuzzy DEMATEL analysis is used as a statistical test in the research and tries to identify and explore various manager's perspectives surrounding the implementation of digital leadership and its barriers and enablers in the work environment.

The results tables are clearly illustrated and labelled, alongside the research findings linked to the objectives of the study, as well as various reviewed literatures. The study then concludes with a discussion of findings, summary, various limitations encountered and recommendations for future directions of the research.

Keywords: Digital leadership, Barriers, Enablers, Manufacturing industry, Fuzzy DEMATEL, UK

Introduction

Currently, various industries are experiencing the transformative effect of digital management and leadership (Xing, Cropley, Oppert & Singh, 2021); meanwhile there has been little theoretical and observational research examining how various manufacturing industries are digitally transformed. (Albukhitan, 2020). According to Sheninger (2019), Eberl and Drews (2021), digital leadership employs the strategic use of an organisation's digital resources to achieve specific and targeted business objectives that can be approached at an organizational and individual level. For these purposes, organizations that value digital leadership, commonly place importance on innovation and a desire to investigate new ways that digital information can be used to tackle external and internal projects which affect the overall business decisions (Soon and Salamzadeh, 2021).

The importance of this research is to access the concept, investigate and rank the main barriers and enablers of digital leadership in the manufacturing industry. In this digital age, the usefulness of digital leadership cannot be overemphasized as it helps to build a digital working culture within an organisation, as well as identify new opportunities. It is therefore crucial for a business to have a digital leader who is focused on the use of digital technologies, creation of digital strategies that will help the business achieve its goals. (Hensellek, 2020; Salamzadeh et al., 2021). Despite the growing adoption of digital leadership in industries, there are various organisations that find it difficult to transition due to traditional leadership processes. A valuable step in understanding a leader's influence is the evaluation of leadership styles and attitude towards digitalization. (Saleem, Aslam, Yin & Rao, 2020). Another challenge is characterized by specific competencies and abilities needed to enhance organisational performance. (Freitas, Cabral & Brinkhues, 2020; Maruthuvellu et al., 2022). As a result of this, companies are trying to develop strategies that can create organisational strengths and align the use of new digital technologies with existing information technology (Della Corte, Del Gaudio & Sepe, 2019); there would be a need to balance these factors to produce ideas for digital innovation (Kohli & Melville, 2019).

In the current times, digital leadership has shifted from the traditional era to this modern era of artificial intelligence that considers the inevitable digitalization of workplaces. There is however, a lack of research on the usefulness of digital leadership in the manufacturing industry as a lot of emphasis is placed on the production industries which might restrict the formulation of strategies and business processes. (Pinto, Salume, Barbosa and De Sousa, 2022).

The aim and objectives of this research are:

- To investigate and examine the main barriers of digital leadership in the manufacturing industry in the UK.
- To define and analyse the main enablers of digital leadership in the manufacturing industry in the UK.
- To rank the main barriers of digital leadership in the manufacturing industry in the UK from various level manager's perspective.

Literature Review

Definitions

Digital leadership

The concept of digital leadership is linked to the implementation of digital transformation within an organization, alongside the process of digitizing the work environments and learning cultures. (Hensellek, 2020). Digital leaders are those that prioritize the development of a digital learning culture throughout the company. In this case, a digital leader is proactive about exploring the usefulness of information technology while being more perceptive to the business needs and adapting to a changing environment. (Petrucci & Rivera, 2018). Hence, a clear separation between process automation and maximization should be established, as the organisational methods that govern digital transformation extends beyond the business model, and can affect goods, services and the business paradigm. (Nadkarni & Prugl, 2021). Mikl, Herold, Pilch, Cwiklicki and Kummer (2020) have described the necessity to adopt disruptive technology in order to boost value creation and digital transformation which in return will require the establishment of a sustainable digital learning culture (Ebert & Duarte, 2018). Over the years, the competition between enterprises has extended to the market and this has resulted in both positive and negative changes (Lancieri & Sakowski, 2021). Digital leadership ensures optimization for companies that can identify and respond to various market developments.

Dimensions of digital leadership

According to Gudergan, Mugge, Kwiatkowski, Abbu, Hoeborn and Conrad (2021), the concept of digital leadership is viewed holistically and is classified into three dimensions.

- Leadership that utilizes digital tools (e.g., employee feedback platforms).
- Leadership that is focused on various leading digital natives.
- Leadership during the process of digital transformation.

There are several smart leaders who utilize digital tools to great effect and understand the new ways that these tools work for the organisation. Hence, progressively smarter information management solutions should allow for rapid and easier access to business data. Nadkarni and Prugl (2021) have described in the context of digital transformation, the importance of culture and selection of experienced employees in a specific work area. This is why companies can build certain digital capabilities which is critical for the ultimate company's future success.

Importance and Characteristics of Digital Leadership

The beneficial effect of a balanced digital approach can be wide ranging for businesses (Fatin & Rahman, 2020), which is why it is essential and beneficial to have a leadership strategy.

Develop a strategic vision

Digital leadership can help an organisation evolve and develop a strategic vision for their digital change. This vision will aid the best use of these digital technologies such as Internet of things – websites, virtual technology and others to achieve its business goals (Vrana & Singh, 2021), therefore, ensuring that all employees can work towards the same objectives.

Build a digital working culture

According to Miller (2020), a working digital culture will be one that is focused on the use of digital resources and technologies to work more efficiently. With this purpose, digital leadership can help in building a digital working culture within an organisation.

Enhance workplace productivity

The use of digital technologies within the organisation can aid the automation of tasks and business processes. This will enhance the employees' focus on more important tasks and additionally improve communication and teamwork within the organisation.

Increase Business Revenue

As a digital leader can use technologies to create value for the organisation, it is envisaged that various new opportunities are identified and implemented to greatly boost revenue.

Barriers and Enablers of Digital Leadership

Digital leadership enablers include various tools that helps the business to take advantage of the influence of information technology in order to aid efficiency. (Wiesbock & Hess, 2020). Below you can see some of the barriers and enablers of digital leadership.

Management and organisational factors

Management and organisational issues can be a challenge for businesses as they try to develop and manage daily operations. A major cause of this might be the discontentment of employees with leadership authorities and the feeling of dissatisfaction. (Miller, 2020). It is important to identify the problem and resolve these issues to create a healthy working environment.

Technological factors

Technology is essential for operations and can largely help to launch growth effectively. On one hand, it might bring a revolution to the business, on the contrary, the use of robust technological tools can quickly become frustrating and difficult to learn (Masood & Egger, 2019), this might be a barrier to achieving the business aims and objectives on the long run.

Leadership characteristics

The characteristic of a leader is crucial to determining the role played in digital leadership. According to Fatin and Rahman (2020), a leader's traits would help in determining the implementation of digital transformation and could be a barrier if it is not properly accounted.

Perception of risk

There are risks factors such as people's beliefs, judgements and attitudes that explores the wider social and cultural values, alongside people's outlook and adaptation. Digital transformation can pose a challenge and there is a possibility that the barriers might have an impact.

Culture and leadership style

Leadership influences culture massively and allows for leaders to enhance organisational values by ensuring growth and development through set objectives and goal orientation.

Processes and Infrastructure

This shows that there is a foundation of an organization's process and aims to ensure that there is a comprehensive set of options available to perform processes effectively.

Strategic vision and skills

There would be a high-level vision and direction that aids critical thinking and problem solving. Tables 1 and 2, below illustrate the importance of the barriers and enablers of digital leadership as it relates with its current performance in the manufacturing industry. This shows the barriers, the sources from which these are gotten and the importance in the context of this research.

Table 1: Importance of the digital leadership barriers

Importance of the Barriers	*Performance In the Manufacturing Industry*	*Sources*
Revolution to the business	The launch of growth and surge	Mikl et al. (2020)
Execution of transformation	Management of daily operations	Fatin & Raman (2020)
Employees outlook adaptation	Culture and attitude to work	Vrana & Singh (2021)

Table 2: importance of the digital leadership enablers

Importance of the Enablers	*Performance In the Manufacturing Industry*	*Sources*
Higher employee engagement	Enhancement of business value	Attaran (2020)
Work motivation / efficiency	Rise in productivity of employees	Kane et al. (2019)
Growing profitability / value	Business revenue increase boost	Hensellek (2020)

Conclusively, the concept of digital leadership has been outlined, including the dimensions, importance and characteristics. Additionally, the barriers and enablers are considered and issues surrounding its usefulness. Attaran (2020) has suggested that the afore mentioned factors are crucial to achieving digital transformation alongside the utilization of business automation.

In our research, after some preliminary interviews with experts, it is decided to consider the below 5 categories as the main categories of barriers and enablers of digital leadership in manufacturing sector in UK:

- Leadership characteristics
- Risks perception
- Technological factors
- People management
- Constraints on resources

Research Methodology

The methodology outlines the processes and exact activities of the research with an emphasis on how data is measured, outcomes interpreted and attempts to be as transparent as possible. Yin (2018) describes the research methodology as a set of systems, procedures, methods or rules that are used to conduct a structured research process for a particular study.

Population and Sample Size

The focus of this study includes senior level, middle and low-level managers of the information technology and information systems department of a manufacturing and retail company. For this research, a sample size of 6 is used as there is a focus on very small samples, to aid the data analysis. According to McKenney and Reeves (2018), the basis for the selection of research participants is the ability to provide a detailed description of their experiences and the willingness to articulate their perspectives, thereby providing relevant information that will enrich the researcher's knowledge and aid the quick gathering of data required. Bryman and Bell, (2015) are of the opinion that the use of open-ended questions and matrices would enable the researcher to find out happenings worldwide in relation to the research topic and scope. It is likely that the inductive approach for this research is particularly relevant to the context. Hence, unlike the deductive approach which uses large samples of subjects, small samples are more suitable. With the use of both qualitative and quantitative information in this research, the inductive approach has been applied to this study.

Case Study

Table 3 shows the general information about the case of the current study.

Table 3: Summary of the information about the case of the current study

Variables	*Implementation*
Managers	Senior, middle and low-level managers
Industry type	Manufacturing / Retail industry
Department	Information technology/ system
Concept considered	Digital leadership
Use of data collected	Ranking of barriers and enablers

The organization considered for this research is Sofology Limited – brought about by DFS, is a leading manufacturer and retailer that specialises in sofas across the UK, making it the country's third largest furniture retailer. The business was founded in 1974 and focuses on retailing sofas. From a financial point of view, its parent company recorded sales of up to £1bn in the year 2019 and Sofology contributed £214.6m to the total revenue, compared to £181.7m in the previous year. The financial report as produced by Nunis (2021), shows that the company is continuing to perform well and is in a good financial health. The values of the company include the perfect customer and team experience and is continually aimed at delivering values.

Fuzzy DEMATEL

To analyse and find the interconnection between the factors found from literature review, the benefits of DEMATEL approach and Fuzzy logic methods together are used and following the below steps, a Fuzzy DEMATEL analysis can be performed (Wu and Lee, 2007; Zhou et al., 2011; Farooque et al., 2020; Liu et al., 2021).

Step 1: Determine the decision objective and the factors that influence the study's objective. Many literature reviews are required in this phase to seek for and collect useful information. Furthermore, a committee of experts is required to supply group expertise for relevant topics. Based on the information gathered and expert opinion, this approach determines potential factors influencing the decision objective. Following agreement on the criteria, an expert panel survey is done to evaluate the interaction between each pair of factors. By doing so, linguistic assessments of which factors have direct effects on each other are obtained.

Step 2: Compile the expert assessments to create the initial direct-relation matrix. Transform the linguistic assessments into triangular fuzzy numbers. Then, using the CFCS approach, aggregate these fuzzy numbers to get crisp scores based on Fuzzy DEMATEL formulae. As a result, aij denotes the direct impact of factor i on component j. As a result, the initial direct-relationship matrix A is formed.

Step 3: Using the DEMATEL approach, create a cause-effect relationship diagram and a structural model of system factors. The total-relation matrix can be simply constructed using the original direct-relation matrix produced in Step 2. The importance degree and net impact degree are then computed, and the cause-effect relationship diagram is built, thereby the structural relationship of factors is visualized.

Step 4: Examine the system factors' structure and find CSFs. Analyse each system factor considering the indices r_i, c_i, $r_i + c_i$, $r_i - c_i$, and the depicted diagram. Considering the position of each factor in the overall system, it is possible to determine which ones have the most impact on the system and there can be a significant enhancement of system efficiency if these factors are prioritized. And these are obviously CSFs that are highly crucial for the entire system.

The Research Steps

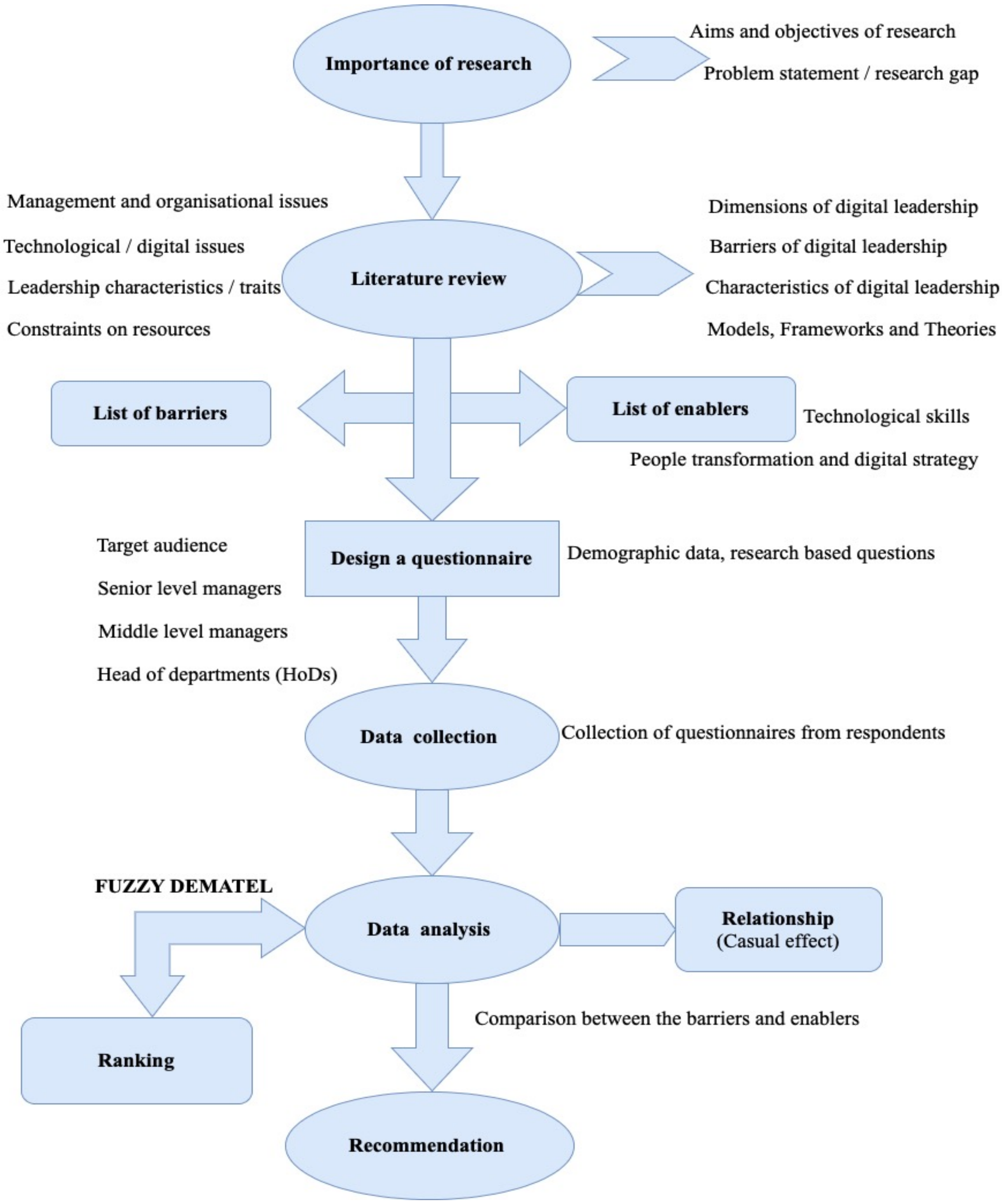

Figure 1: Flowchart of the research

Figure 1 shows the step-by-step methods carried out throughout the process of this research. A transparent approach was utilised to assess and scrutinize relevant information to ensure that the readers are not misled during the continuous study and analysis. The statistical test used in the research is explained and the chapter is concluded by outlining a chart of the research steps, alongside a summary of data collection approach and analysis of strategies used.

Research Findings

Analysing The Barriers of Digital Leadership

Step One: Generate the fuzzy direct – relation matrix:

The process of identifying the model of the relations involves the use of criteria, n, and an n * n matrix is first generated. The impact of the element in each row applied on the element in each column of this matrix is represented with a fuzzy number. If multiple experts' opinions are used, all matrices must be completed. The arithmetic mean of all the opinions are now used to generate the direct relation matrix z. Table 4 shows the direct relation matrix and table 5 shows the fuzzy scale used for the analysis.

$$z = \begin{bmatrix} 0 & \cdots & \tilde{z}_{n1} \\ \vdots & \ddots & \vdots \\ \tilde{z}_{1n} & \cdots & 0 \end{bmatrix}$$

Table 4: The direct relation matrix

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	(0.000,0.000,0.000)	(0.375,0.625,0.750)	(0.375,0.625,0.833)	(0.625,0.875,1.000)	(0.250,0.417,0.583)
Technological factors	(0.292,0.542,0.792)	(0.000,0.000,0.000)	(0.125,0.375,0.625)	(0.083,0.292,0.542)	(0.250,0.458,0.667)
Constraints on resources	(0.333,0.583,0.792)	(0.125,0.250,0.500)	(0.000,0.000,0.000)	(0.208,0.417,0.667)	(0.333,0.583,0.792)
Risks perception	(0.250,0.458,0.667)	(0.083,0.292,0.542)	(0.417,0.583,0.708)	(0.000,0.000,0.000)	(0.250,0.500,0.750)
Leadership characteristics	(0.375,0.542,0.667)	(0.333,0.542,0.750)	(0.333,0.542,0.708)	(0.208,0.417,0.667)	(0.000,0.000,0.000)

Table 5: Fuzzy Scale

Code	Linguistic terms	L	M	U
1	No influence	0	0	0.25
2	Very low influence	0	0.25	0.5
3	Low influence	0.25	0.5	0.75
4	High influence	0.5	0.75	1
5	Very high influence	0.75	1	1

Step Two: Normalize the fuzzy direct-relation matrix

The normalized fuzzy direct-relation matrix can be obtained using the following formula:

$$\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right)$$

where

$$r = \max_{i,j}\left\{\max_{i}\sum_{j=1}^{n} u_{ij}, \max_{j}\sum_{i=1}^{n} u_{ij}\right\} \qquad i,j \in \{1,2,3,\dots,n\}$$

The normalized matrix is shared as table 6.

Table 6: The normalized fuzzy direct-relation matrix

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	(0.000,0.000,0.000)	(0.118,0.197,0.237)	(0.118,0.197,0.263)	(0.197,0.276,0.316)	(0.079,0.132,0.184)
Technological factors	(0.092,0.171,0.250)	(0.000,0.000,0.000)	(0.039,0.118,0.197)	(0.026,0.092,0.171)	(0.079,0.145,0.211)
Constraints on resources	(0.105,0.184,0.250)	(0.039,0.079,0.158)	(0.000,0.000,0.000)	(0.066,0.132,0.211)	(0.105,0.184,0.250)
Risks perception	(0.079,0.145,0.211)	(0.026,0.092,0.171)	(0.132,0.184,0.224)	(0.000,0.000,0.000)	(0.079,0.158,0.237)
Leadership characteristics	(0.118,0.171,0.211)	(0.105,0.171,0.237)	(0.105,0.171,0.224)	(0.066,0.132,0.211)	(0.000,0.000,0.000)

Step Three: Calculate the fuzzy total-relation matrix

The fuzzy total-relation matrix can be calculated by the following formula:

$$\tilde{T} = \lim_{k\to+\infty}(\tilde{x}^1 \oplus \tilde{x}^2 \oplus \dots \oplus \tilde{x}^k)$$

If each element of the fuzzy total-relation matrix is expressed as $\tilde{t}_{ij} = (l''_{ij}, m''_{ij}, u''_{ij})$,it can be calculated as follows:

$$[l''_{ij}] = x_l \times (I - x_l)^{-1}$$

$$[m''_{ij}] = x_m \times (I - x_m)^{-1}$$

$$[u''_{ij}] = x_u \times (I - x_u)^{-1}$$

In other words, the normalized matrix the inverse is first calculated, and then it is subtracted from the matrix I, and finally the normalized matrix is multiplied by the resulting matrix. The table 7 shows the fuzzy direct-relation matrix.

Table 7: Total Fuzzy direct-relation matrix

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	(0.067,0.297,1.597)	(0.154,0.408,1.615)	(0.178,0.466,1.792)	(0.235,0.510,1.832)	(0.134,0.396,1.701)
Technological factors	(0.120,0.358,1.581)	(0.030,0.178,1.234)	(0.074,0.319,1.534)	(0.062,0.292,1.522)	(0.103,0.322,1.506)
Constraints on resources	(0.142,0.387,1.633)	(0.075,0.269,1.420)	(0.048,0.235,1.423)	(0.108,0.343,1.604)	(0.136,0.372,1.586)
Risks perception	(0.119,0.354,1.566)	(0.060,0.273,1.391)	(0.166,0.387,1.564)	(0.043,0.220,1.386)	(0.114,0.350,1.538)
Leadership characteristics	(0.162,0.396,1.617)	(0.138,0.353,1.480)	(0.150,0.397,1.612)	(0.114,0.357,1.608)	(0.048,0.233,1.394)

Step Four: Defuzzify into crisp values

The steps of CFCS method are as follows:

$$l_{ij}^{n} = \frac{\left(l_{ij}^{t} - \min l_{ij}^{t}\right)}{\Delta_{min}^{max}}$$

$$m_{ij}^{n} = \frac{(m_{ij}^{t} - min\ l_{ij}^{t})}{\Delta_{min}^{max}}$$

$$u_{ij}^{n} = \frac{(u_{ij}^{t} - min\ l_{ij}^{t})}{\Delta_{min}^{max}}$$

So that

$$\Delta_{min}^{max} = \max u_{ij}^{t} - \min l_{ij}^{t}$$

Calculating the upper and lower bounds of normalized values:

$$l_{ij}^{s} = m_{ij}^{n} \Big/ (1 + m_{ij}^{n} - l_{ij}^{n})$$

$$u_{ij}^{s} = u_{ij}^{n} \Big/ (1 + u_{ij}^{n} - l_{ij}^{n})$$

The output of the CFCS algorithm is crisp values.

Calculating total normalized crisp values:

$$x_{ij} = \frac{[l_{ij}^s(1 - l_{ij}^s) + u_{ij}^s \times u_{ij}^s]}{[1 - l_{ij}^s + u_{ij}^s]}$$

Table 8 shows the normalized crisp values.

Table 8: Normalized crisp values

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	0.509	0.595	0.67	0.714	0.601
Technological factors	0.554	0.361	0.52	0.499	0.519
Constraints on resources	0.584	0.462	0.439	0.552	0.568
Risks perception	0.55	0.459	0.582	0.421	0.544
Leadership characteristics	0.59	0.537	0.594	0.563	0.431

Step Five: Set the Threshold value

To calculate the internal relations matrix, it is essential to obtain the threshold value. One-sided relations are overlooked and the NRM which is the network relationship map is charted. The only relations with values in matrix T greater than the threshold values are represented in the network relationship map. To calculate the threshold value for relations, it is appropriate to calculate the average values of the matrix, T. Once the threshold intensity is determined, all the values in matrix T which are smaller than the threshold value are set to zero, which is, the causal relation as mentioned. In this research, the threshold value is equal to 0.537. All the values in matrix T which are smaller than 0.537 are set to zero, that is, the causal relation mentioned is not considered. Table 9 shows the result of the above calculations.

Table 9: Revised table considering the threshold value

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	0	0.595	0.67	0.714	0.601

Technological factors	0.554	0	0	0	0
Constraints on resources	0.584	0	0	0.552	0.568
Risks perception	0.55	0	0.582	0	0.544
Leadership characteristic	0.59	0.537	0.594	0.563	0

Step 6: Final output and create a causal relation diagram.

The next step is to find out the sum of each row and each column of T (in step 4). The sum of rows (D) and columns (R) can be calculated as follows:

$D = \sum_{j=1}^{n} T_{ij}$

$R = \sum_{i=1}^{n} T_{ij}$

Then, the values of D+R and D-R can be calculated by D and R, where D+R represent the degree of importance of factor i in the entire system and D-R represent net effects that factor *i* contributes to the system. Table 4.3.6. below shows the final output.

The final output

The final output of the analysis shared above is presented in table 10 below.

Table 10: Final output to calculate the cause-and-effect relationships

	R	D	D+R	D-R
People management	2.787	3.089	5.876	0.302
Technological factors	2.413	2.453	4.866	0.039
Constraints on resources	2.806	2.606	5.411	-0.2
Risks perception	2.75	2.556	5.306	-0.194
Leadership characteristics	2.663	2.715	5.379	0.052

The figure below shows the model of significant relations. This is represented as a diagram in which the values of (D+R) are placed on the horizontal axis and the values of (D-R) on the vertical axis. The interaction and position of each factor with a point in the coordinates (D+ R, D-R) are determined by respective coordinate system. To have a better view of the results, figure 2, below, is sharing the final profile of the barriers of digital leadership.

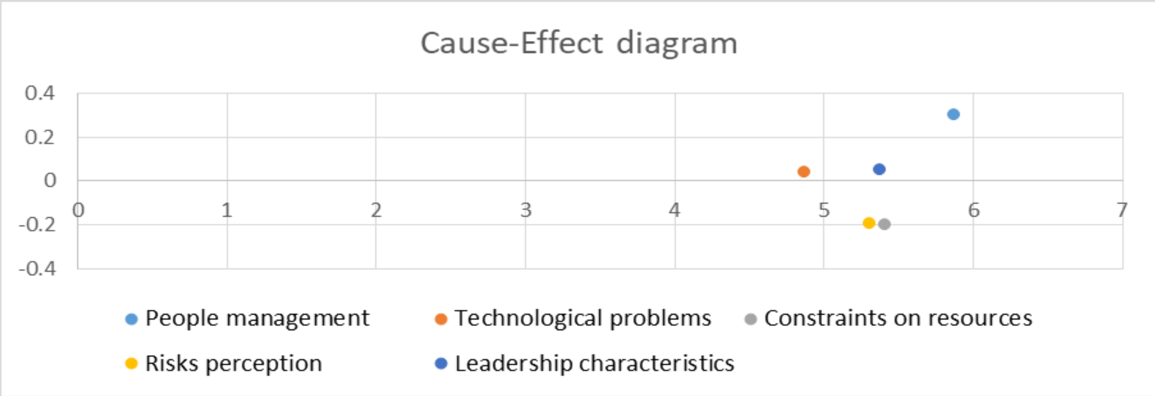

Figure 2: Cause and effect relationship of barriers of digital leadership

Analysing The Enablers of Digital Leadership

Step One: Generate the fuzzy direct – relation matrix:

The process of identifying the model of the relations involves the use of criteria, n, and an n * n matrix is first generated. The impact of the element in each row applied on the element in each column of this matrix is represented with a fuzzy number. If multiple experts' opinions are used, all matrices must be completed. The arithmetic mean of all the opinions are now used to generate the direct relation matrix z.

$$z = \begin{bmatrix} 0 & \cdots & \tilde{z}_{n1} \\ \vdots & \ddots & \vdots \\ \tilde{z}_{1n} & \cdots & 0 \end{bmatrix}$$

The fuzzy direct-relation matrix for enablers of digital leadership is shared in table 11 and table 12 shows the fuzzy scale used in the calculation.

Table 11: fuzzy direct-relation matrix for enablers of digital leadership

	People management	Technological Factors	Constraints on resources	Risks perception	Leadership characteristics
People management	(0.000,0.000,0.000)	(0.250,0.417,0.625)	(0.542,0.750,0.875)	(0.375,0.625,0.792)	(0.333,0.542,0.750)
Technological factors	(0.375,0.625,0.833)	(0.000,0.000,0.000)	(0.167,0.417,0.667)	(0.417,0.667,0.875)	(0.167,0.417,0.667)
Constraints on resources	(0.208,0.458,0.667)	(0.250,0.417,0.625)	(0.000,0.000,0.000)	(0.208,0.417,0.667)	(0.500,0.708,0.875)
Risks perception	(0.208,0.375,0.625)	(0.125,0.375,0.625)	(0.458,0.708,0.875)	(0.000,0.000,0.000)	(0.250,0.417,0.625)
Leadership characteristics	(0.292,0.458,0.625)	(0.333,0.500,0.708)	(0.125,0.333,0.583)	(0.125,0.208,0.458)	(0.000,0.000,0.000)

Table 12: Fuzzy Scale

Code	Linguistic terms	L	M	U
1	No influence	0	0	0.25
2	Very low influence	0	0.25	0.5
3	Low influence	0.25	0.5	0.75
4	High influence	0.5	0.75	1
5	Very high influence	0.75	1	1

Step Two: Normalize the fuzzy direct relation matrix

The normalized fuzzy direct-relation matrix can be obtained using the following formula:

$$\tilde{x}_{ij} = \frac{\tilde{z}_{\mathrm{ij}}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right)$$

where

$$r = \max_{i,j}\left\{\max_{i}\sum_{j=1}^{n} u_{ij}, \max_{j}\sum_{i=1}^{n} u_{ij}\right\} \qquad i,j \in \{1,2,3,\dots,n\}$$

Table 13 is sharing the normalized fuzzy direct-relation matrix as per the above calculation.

Table 13: The normalized fuzzy direct relation matrix

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	(0.000,0.000,0.000)	(0.082,0.137,0.205)	(0.178,0.247,0.288)	(0.123,0.205,0.260)	(0.109,0.178,0.247)
Technological factors	(0.123,0.205,0.274)	(0.000,0.000,0.000)	(0.055,0.137,0.219)	(0.137,0.219,0.288)	(0.055,0.137,0.219)
Constraints on resources	(0.068,0.151,0.219)	(0.082,0.137,0.205)	(0.000,0.000,0.000)	(0.068,0.137,0.219)	(0.164,0.233,0.288)
Risks perception	(0.068,0.123,0.205)	(0.041,0.123,0.205)	(0.151,0.233,0.288)	(0.000,0.000,0.000)	(0.082,0.137,0.205)
Leadership characteristic	(0.096,0.151,0.205)	(0.109,0.164,0.233)	(0.041,0.109,0.192)	(0.041,0.068,0.151)	(0.000,0.000,0.000)

Step Three: Calculate the fuzzy total-relation matrix

In step 3, the fuzzy total-relation matrix can be calculated by the following formula:

$$\tilde{T} = \lim_{k\to+\infty}(\tilde{x}^1 \oplus \tilde{x}^2 \oplus \dots \oplus \tilde{x}^k)$$

If each element of the fuzzy total-relation matrix is expressed as $\tilde{t}_{ij} = (l''_{ij}, m''_{ij}, u''_{ij})$, it can be calculated as follows:

$$[l''_{ij}] = x_l \times (I - x_l)^{-1}$$

$$[m''_{ij}] = x_m \times (I - x_m)^{-1}$$

$$[u''_{ij}] = x_u \times (I - x_u)^{-1}$$

In other words, the normalized matrix the inverse is first calculated, and then it is subtracted from the matrix I, and finally the normalized matrix is multiplied by the resulting matrix. The table 14 shows the fuzzy direct-relation matrix.

Table 14: Fuzzy total direct relation matrix

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	(0.061,0.282,2.289)	(0.132,0.379,2.354)	(0.229,0.524,2.687)	(0.172,0.450,2.517)	(0.175,0.464,2.617)
Technological factors	(0.159,0.436,2.519)	(0.042,0.241,2.196)	(0.116,0.426,2.659)	(0.175,0.448,2.551)	(0.108,0.408,2.611)
Constraints on resources	(0.114,0.377,2.330)	(0.122,0.346,2.222)	(0.052,0.274,2.311)	(0.111,0.360,2.348)	(0.201,0.460,2.497)
Risks perception	(0.107,0.345,2.285)	(0.081,0.324,2.187)	(0.186,0.458,2.499)	(0.042,0.231,2.134)	(0.132,0.381,2.406)
Leadership characteristics	(0.128,0.329,2.052)	(0.135,0.321,1.983)	(0.086,0.320,2.182)	(0.083,0.265,2.033)	(0.042,0.213,1.986)

Step Four: Defuzzify into crisp values

Defuzzification is a process of converting fuzzy values or numbers into crisp values. Various formulas and methods can be employed to perform this operation.

$lijn{=}(lijt{-}\min lijt)\Delta minmax$ $mijn{=}(mijt{-}min\ lijt)\Delta minmax$ $uijn{=}(uijt{-}min\ lijt)\Delta minmax$

So that

$\Delta minmax{=}\max uijt{-}\min lijt$

Calculating the upper and lower bounds of normalized values:

$lijs=mijn(1+mijn-lijn)/\ uijs=uijn(1+uijn-lijn)/$

The output of the CFCS algorithm is crisp values. Calculating total normalized crisp values:

$xij=[lijs(1-lijs)+uijs\times uijs][1-lijs+uijs]$

The result of the above calculation is shared in table 15 below.

Table 15: The crisp values

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	0.624	0.708	0.881	0.793	0.82
Technological factors	0.781	0.573	0.796	0.797	0.773
Constraints on resources	0.706	0.664	0.625	0.697	0.803
Risks perception	0.675	0.639	0.802	0.56	0.725
Leadership characteristics	0.629	0.609	0.642	0.573	0.523

Step Five: Set the Threshold value

To calculate the internal relations matrix, it is essential to obtain the threshold value. One-sided relations are overlooked and the NRM which is the network relationship map is charted. The only relations with values in matrix T greater than the threshold values are represented in the network relationship map. Once the threshold intensity is determined, all the values in matrix T which are smaller than the threshold value are set to zero, which is, the causal relation as mentioned. In this research, the threshold value is equal to 0.537, 0.537. All the values in matrix T which are smaller than 0.5370.537 are set to zero, that is, the causal relation mentioned is not considered. The result of this calculation is shared in the table 16 below.

Table 16: Adding the threshold values to the calculations

	People management	Technological factors	Constraints on resources	Risks perception	Leadership characteristics
People management	0	0.708	0.881	0.793	0.82
Technological factors	0.781	0	0.796	0.797	0.773
Constraints on resources	0.706	0	0	0.697	0.803
Risks perception	0	0	0.802	0	0.725
Leadership characteristics	0	0	0	0	0

Step Six: Final output and create a causal relation diagram

The next step is to find out the sum of each row and each column of T (in step 4). The sum of rows (D) and columns (R) can be calculated as follows:

$D=\Sigma Tijnj=1$

$R=\Sigma Tijni=1$

Then, the values of D+R and D-R can be calculated by D and R, where D+R represent the degree of importance of factor i in the entire system and D-R represent net effects that factor *i* contributes to the system. The table 17 shows the final output.

Table 17: The final output for enablers of digital leadership

	R	D	D+R	D-R
People management	3.415	3.826	7.242	0.411
Technological factors	3.193	3.72	6.913	0.527
Constraints on resources	3.746	3.495	7.241	-0.251
Risks perception	3.42	3.401	6.821	-0.019
Leadership characteristics	3.644	2.975	6.619	-0.668

In order to make a clearer presentation of the above table, the schematic view of the results is shared in figure 3 below.

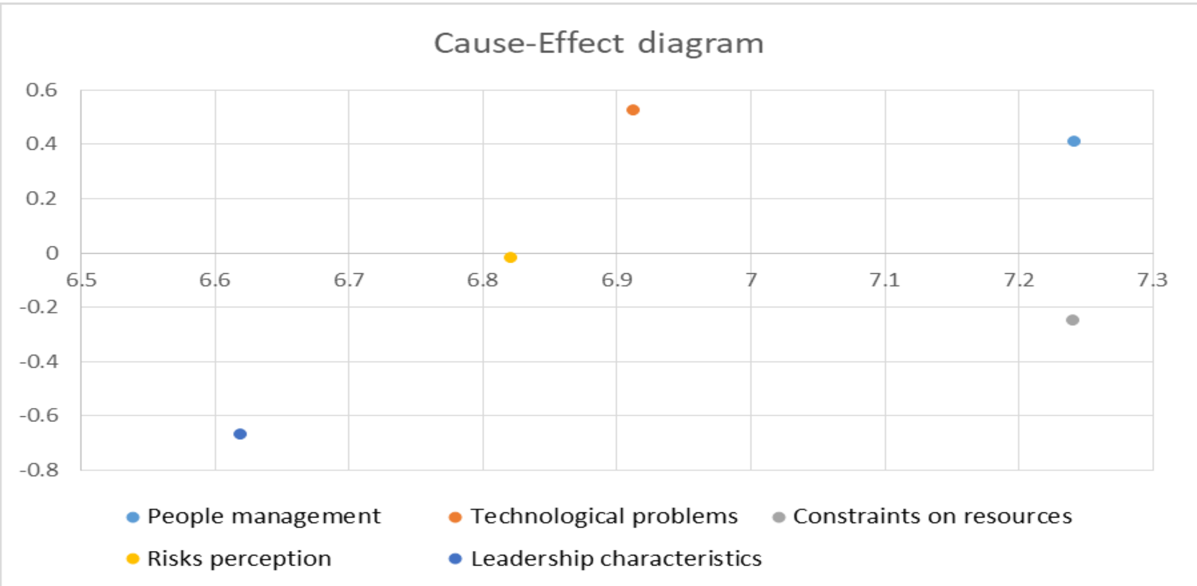

Figure 3: Final cause and effect diagram for digital leadership enablers

Conclusion

The cause and effects diagrams illustrated in the analysis shows that various items are more important than some others and there is a degree of importance and critical factors. The horizontal vector (D + R) represents the degree of importance between each factor and indicates both factor I's impact on the overall system and other system factors. According to Khan and Haleem (2020), the barriers in this case will be identified as critical factors that influences the effects of digital leadership which will eventually serve as a tool for making decisions in the future. The final output diagram illustrates the horizontal vector (D + R) and vertical vector (D – R). The horizontal vector shows the degree of importance between each factor in the system which indicates the factor's impact, system factor's impact. In order of rank, People management (F1) is ranked in first place while Constraints on resources (F3), Technological factors (F2), Risk perception (F4), Leadership characteristics (F5), are ranked in the next places. The barriers are ranked accordingly as F1, F2, F5 are considered as a causal variable, while F3, and F4 are regarded as an effect. The causal variable in this case may fluctuate, as the first variable may bring the second into existence or may cause the incidence of the second variable to be altered. (Chummee, 2021). The vertical vector (D – R) shows the degree of a factor's influence on system. According to the degree of importance, the following are ranked, People management is ranked in the first place, while Technological factors, Constraints on resources, Leadership characteristics, Risks perception, are ranked in the next places. In this research, People management, Technological factors, Leadership characteristics are a causal variable, while Constraints on resources and Risks perception are regarded as an effect.

The cause and effects diagrams illustrated in the analysis above, each factor can be assessed based on the following aspects: The horizontal vector (D + R) represents the degree of importance between each factor and indicates both factor I's impact on the overall system and other system factors. In terms of the degree of importance, People management (F1) is ranked in first place while Constraints on resources (F3), Technological factors (F2), Risks perception

(F4), and Leadership characteristics (F5) are ranked in the next places. In this research, people management and technological factors are a causal variable while constraints on resources, risks perception, leadership characteristics are regarded as an effect. According to Classen and Friedli (2021), it is important to assess various factors that might promote the development of strategies that aligns with the business processes and IT resources. In addition, there is a need to manage such strategies to aid the leadership intervention. The vertical vector (D – R) which illustrates the degree of a factor's influence on the system shows the overall, the positive value of D – R represents a causal variable, while the negative value of D – R represents an effect. On a scale of importance, People management (F1) is ranked in first place and Technological factors (F2), Leadership characteristics (F5), Constraints on resources (F3), Risk perception (F4). In this research, leadership characteristics, constraints on resources, risks perception are regarded as an effect while technological factors and people management are a causal variable. A well-established framework emphasizes that the effectiveness of digital leadership is in the integration of competing leadership roles and revolves around the organizational culture, human resource management, and technical skills (Akhtar, Frynas, Mellahi & Ullah, 2019). With a focus on organisational leadership behaviour, there should be a taxonomy of managerial roles that describes the values that leaders face in a complex organizational environment. Ibrahim and Daniel (2019) have identified various leadership roles that are embedded in 4 quadrants which are called Create, Collaborate, Compete and Control. The ability and skill to exhibit such extensive range of behaviour is known as behavioural complexity (Ebert, 2018), and is related to managerial and leadership effectiveness. (Vilkinas, Murray & Chua, 2020).

The process of implementing digital leadership will require proper utilization of technical capacities, however, the limitation in resources is a major characteristic of businesses. Lokuge and Sedera (2020) are of the opinion that for an organisation to be successful in digital transformation, it is essential to manage and develop competencies, mind-set, and skill set, as this will determine the future success and achievements.

Conclusively, this study has explored the concept of digital leadership alongside its main barriers and enablers in the manufacturing industry. Several major categories relating to digital transformation and the rationale behind the implementation of digital leadership in the industry kept recurring and the study was able to access the barriers and enablers in relation to the objectives of the research. This study identified and assessed the rationale behind the implementation of digital leadership, its dimensions and the characteristics. While there is a need for digital transformation in the industry, it is also important to address the primary concerns about ethical protocols and the full benefits of its implementation in the work place. The process of digitization can pose a huge challenge and there is an immense possibility that the barriers might have an impact on the business. It is required that the organisation keep an eye on the external environment for current trends and digital developments that are relevant to the business for improvements and evaluation. Over the years, the competition between business enterprises has extended to the market and this has resulted in both positive and negative changes in the general market. (Lancieri & Sakowski, 2021). The objective of digital leadership and transformation, however, ensures the continual optimization for organisations that are capable of identifying and responding rapidly to various market developments.

Implications of Research

The research findings were crucial to business organisation in various ways and has revealed the viewpoints of various level managers in the industry which are widely different. While managers are quick to implement a system or process in the organisation, it is essential to firstly consider the potential impact of the system on the employee, as well as the usefulness of the concept. The business should be allowed to take into consideration, the pros and the cons, as well as the employee’s perspective and the effect and outlook. The results derived from this study might provide various level managers, employers and leaders with the fundamental knowledge to identify and examine their current practices in the workplace. Various ways and strategies to improve the organisation's policies and regulations can be considered, while carrying out an assessment of potential impact on the work environment.

Recommendations For Further Studies

In this research, a relevant issue that might have been examined could be the cost associated with implementation, ranging from the use of software, system and applications, and others. Going by the literatures reviewed in this study, there appeared to be a lot of emphasis placed in the retail and production industries which in many ways might restrict the formulation of strategies and business processes. It is important to examine interrelated elements and address the factors that might be present in other industries such as the private sector, financial, etc. Conclusively, the importance of digital leadership cannot be over emphasized in the work environment as it gives the overall business an edge over others. Although, there are drawbacks on its use in organisations, it is however important that the purpose of its use is communicated to employees and used specifically to meet the business objectives of the workplace.

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