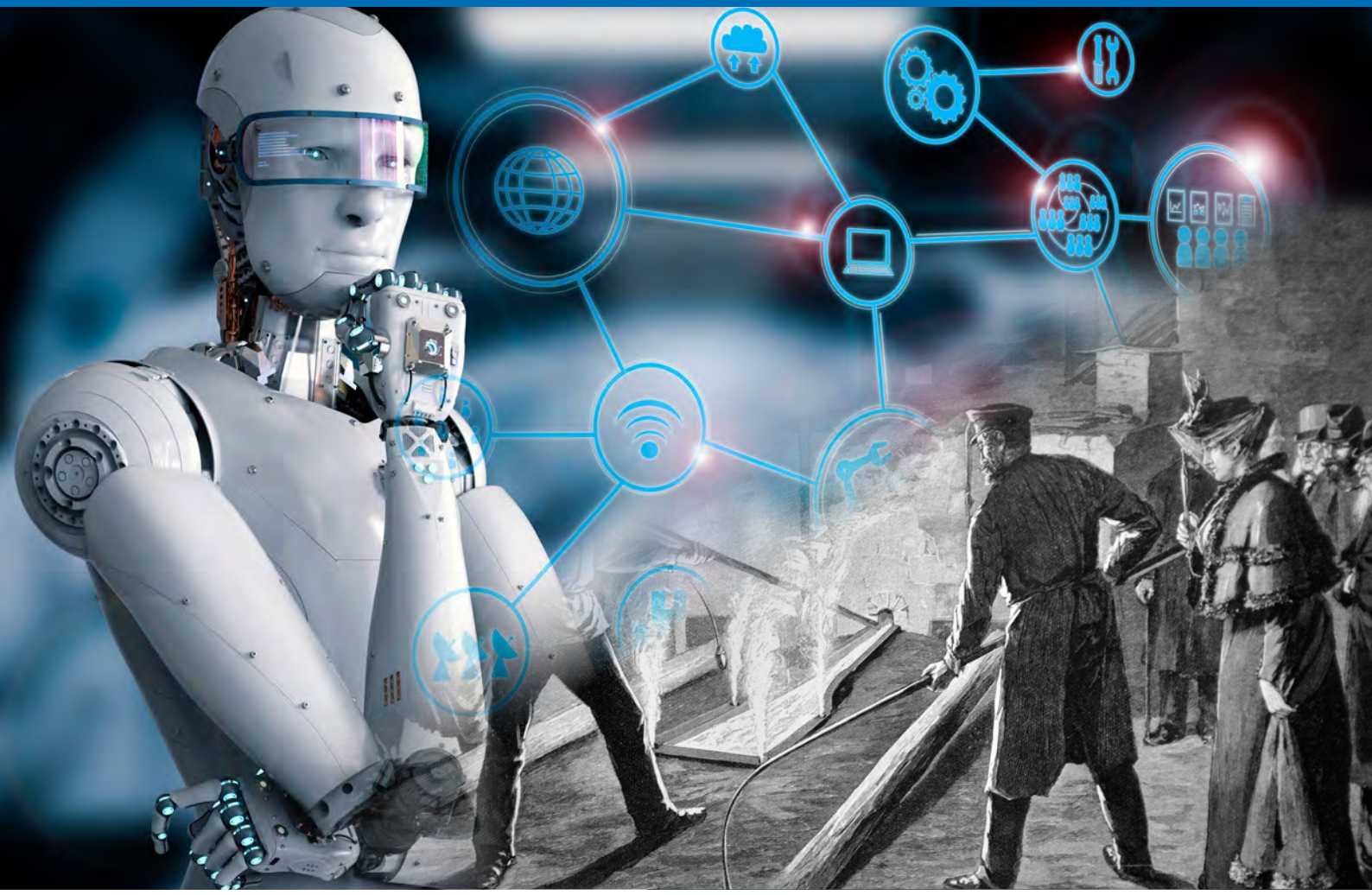
PAS 1040:2019

Digital readiness – Adopting digital technologies in manufacturing – Guide



Innovate UK

bsi.

Publishing and copyright information

Published by BSI Standards Limited 2019.

ISBN 978 0 539 035407

ICS 25.040.01; 35.240.50

Publication history

First published August 2019

Contents

Foreword

Publishing information

This PAS (Publicly Available Specification) was sponsored by Innovate UK. Its development was facilitated by BSI Standards Limited, and it was published under licence from The British Standards Institution. It comes into effect on 31 August 2019.

Acknowledgement is given to Dr Steven Barr of EDGE Digital Manufacturing Limited as the technical author, and to the following organizations that were involved in the development of this PAS as members of the steering group:

- Additive Manufacturing UK
- Atlas Copco IAS UK
- EDGE Digital Manufacturing Limited
- HSSMI Limited
- Innovate UK
- Jaguar Land Rover Limited
- The Manufacturing Technology Centre (a High Value Manufacturing Catapult Centre)
- The Society of Motor Manufacturers and Traders Industry Forum
- Vendigital Limited

Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a guide to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Use of this document

As a guide, this PAS takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice.

Presentational conventions

The guidance in this PAS is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Explanation and general informative material is presented in smaller italic type and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with this PAS cannot confer immunity from legal obligations.

0 Introduction

0.1 Information about this document

In addition to broader information about the context and purpose of this document, and further references, this PAS presents guidelines on:

- getting ready for digital transformation: the aspects that manufacturing businesses should consider when planning and implementing digital technologies (Clause **4**);
- measuring digital readiness: how manufacturing businesses should measure their maturity in optimizing their use of digital technologies (Clause **5**);
- selecting digital readiness diagnostic tools: the factors that manufacturing businesses should consider when selecting digital readiness diagnostic tools (Clause **6**);
- using digital readiness diagnostic tools: how manufacturing businesses should use digital readiness diagnostic tools in optimizing their use of digital technologies (Clause **7**).

0.2 Digital transformation of manufacturing

The UK's Industrial Strategy [1] highlights the opportunity for artificial intelligence, automation, data and other digital technologies to transform all stages of the design, manufacture and beneficial use of products. Digitalization needs to permeate the entire supply chain in order to deliver industry-wide productivity gains. And businesses need efficient digital infrastructures to enable connected and secure systems.

The Made Smarter Review 2017 [2] describes the impact of five key industrial digital technologies (IDTs) and offers a list of technical enablers and business benefits, which are set out in Table 1.

More broadly, digital technologies relevant to manufacturing businesses could include other electronic devices or software that use digital information.

Table 1 – Industrial digital technologies, technical enablers and business benefits

Key industrial digital technologies	Business benefits of digital technologies
Additive manufacturing/ 3D printing	Flexibility
Artificial intelligence/ machine learning and data analytics	Productivity
Robotics and automation (including collaborative robots)	Speed
The Industrial Internet of Things and connectivity (including 5G and LPWAN)	Quality
Virtual reality and augmented reality	Scalability
Other technical enablers	Competitiveness and innovative capability
Cloud storage and computing	Robustness
Cybersecurity and blockchain	Cost reduction
Simulation modelling	Sustainability
Digital twin	Safety
Sensors and tracking (including radio-frequency identification and near-field communication)	Working conditions
Digitally-enabled supply chain management	Continuous learning/ collaboration
Enterprise resource planning software	
Manufacturing execution system	
Mobile/ tablet/ watch	

Source: Made Smarter Review 2017 [2]

0.3 Opportunity

The potential benefits of planned and managed implementation of digital technologies can be substantial. The World Economic Forum's Digital Transformation Initiative estimates "$100 trillion of value that digitalization could create over the next decade" for "digital enterprises" with over 130 initiatives in 12 industries related, directly or indirectly, to manufacturing [3]. The Made Smarter Review estimates that the "positive impact of faster innovation and adoption of IDTs could be as much as £455 billion for UK manufacturing over the next decade" [2].

The extent to which manufacturing businesses step up to claim shares in this substantial prize depends on leadership, informed decision-making and commitment to driving value from investment in digital technologies.

0.4 Challenges

Despite the economic allure of digital technologies, the Made Smarter Review highlights several themes "which are limiting the UK's ability to achieve its potential: [including] poor levels of adoption [of IDTs], particularly among SMEs" [2]. Reasons why manufacturers of any size might be held back include the rapid evolution of digital technologies, and a "confused landscape of business support, with no clear route to access help and ambiguity about what 'good'" looks like" [2].

Adoption of digital technologies might be constrained by factors such as unawareness of their relevance to a business, perceived complexities of integrating them, misconceptions of costs, lack of capability or capacity in the business, poor leadership or narrow strategy. Progress might be slowed or halted altogether by these issues. The process of adoption might never start. Or a business might make poor choices of digital technologies that fail to exploit the opportunities open to it or are not cost-effective.

0.5 Digital readiness level diagnostic tools

The Made Smarter Review recommends a series of actions to achieve an "increased pace of adoption of industrial digital technologies" [2]. These include "creating clear UK standards for digital industries" and the use of "digital readiness level diagnostics" made available in the form of a "national web platform or more in depth diagnostic tools".

In this context, "digital readiness" relates to the maturity of a business in optimizing its use of digital technologies to expand and achieve its organizational, operational, social and financial objectives.

Digital readiness diagnostic tools support progress by formalizing both the measurement of digital readiness and an understanding of the areas a business would need to improve with the help of digital technologies in order to achieve a stronger digital readiness.

Optimization is contextual, relating to the opportunities of a specific business and not necessarily to the sector. A strong digital readiness indicates that the business has chosen the right digital technologies to exploit its opportunities, has implemented them effectively, and is maximizing value in terms of its objectives. A weak digital readiness indicates that action is required to improve business strategy, planning and implementation in order to avoid failure to achieve an adequate return on investment in digital technologies.

0.6 Motivation to invest in digital transformation

The success of suppliers, makers and customers of manufactured goods and services is fundamental to UK economic growth and employment. Together these businesses deliver substantially more than the 11% of gross value added (GVA) and 44% of exports directly attributed to the manufacturing and production industry by the Office for National Statistics [4]. Continuing investment is needed to boost the competitiveness of UK manufacturing.

Digital technologies are enablers for improved productivity and competitiveness. They support collaboration within and between businesses for greater innovation. They engage businesses with customers, enabling mass customization and delivery of tailored services. They protect workers and help in the development of new skills and careers. The future of manufacturing is digital.

0.7 Guidelines for leaders of digital transformation

The guidance in this PAS is intended to inspire any business leader to make progress with digital transformation. The descriptions and examples are written with the needs of suppliers, makers, and customers of manufactured goods and services in mind. This PAS is also of benefit to developers and providers of digital readiness diagnostic tools.

1 Scope

This PAS provides a standardized methodology for assessing the readiness of a business to adopt digital technologies in manufacturing, and for assessing progress along its digital journey.

Digital readiness, the maturity of a business or part of a business in optimizing its use of digital technologies, can be measured on a scale of 1 to 9. This PAS gives guidance for identifying and understanding the range of potential business factors to be taken into consideration in planning and implementing the digital journey.

This PAS considers a broad range of business factors relevant to assessing the readiness of a business to benefit from digital technologies. These factors include leadership, processes and driving value for the business and its partners, all of which are underpinned by the capabilities of the workforce.

This PAS does not cover:

- how to implement new digital technologies;
- any tool elements;
- recommendations of any specific tools;
- how best to implement digital technologies;
- identifying the business opportunities associated with digital manufacturing; or
- defining the business case for digital manufacturing.

This PAS is intended to be used by UK manufacturers of all sizes including suppliers, makers, and customers of manufactured goods and services. This PAS is not intended to be used directly by end consumers. Additionally, the guidance could be used by other businesses who are looking to increase their business efficiencies and competitiveness.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this PAS, the following terms and definitions apply.

3.1 digital readiness

maturity of a business or part of a business in optimizing its use of digital technologies to achieve its organizational, operational, social and financial objectives

3.2 digital readiness diagnostic tool

formalized tool for assessing digital readiness in respect of defined business aspects and objectives

3.3 digital technology

electronic device or software that uses digital information when performing a function, for example those technologies identified by the Made Smarter Review and listed in Table 1

3.4 manufacturing business

supplier or maker of manufactured goods and services

3.5 industry 4.0

name given to the adoption and use of digital technologies in manufacturing also referred to as “Industry 4”, “Industrie 4.0”, “fourth industrial revolution”, or “4IR”

4 Getting ready for digital transformation

4.1 General

Clause **4** sets out the aspects that manufacturing businesses should consider when planning and implementing digital technologies.

4.2 Digital readiness

"Digital readiness" is a measure of the maturity of a manufacturing business or part of a business in optimizing its use of digital technologies by organizing its resources and activities to make best use of the right digital technologies and to drive business value from them.

Table 2 indicates some characteristics of manufacturing businesses with weaker or stronger digital readiness, illustrating the use of the term "digital readiness" in highlighting both opportunities for improvement and the nature of digital technologies that could be appropriate.

Table 2 – Characteristics of digital readiness in aspects of manufacturing

Aspect	Weaker digital readiness	Stronger digital readiness
Leadership vision for digital	The business does not have a digital strategy or road map. Roles and responsibilities for digital technology have not been defined. The business is not aware of the potential benefits of digital technologies. The business plan does not take digital technologies into consideration.	The business has a digital strategy with an implementation roadmap, defined roles and responsibilities and a supporting business case. Use of digital technologies is fully integrated into the vision of the business. Adoption of digital technologies is fully supported by leadership at all levels.
Culture of innovation with digital	The business does not encourage innovation and change. Workers are not encouraged to innovate, and they are not given time or resources to explore the use of digital technologies. The business is risk averse with failure actively avoided.	The business has defined plans and processes in place to invest in new ideas and support pilots. Workers are encouraged to experiment with new digital technologies. Risk taking is incentivized across the business.
Technology integration with digital	The business is not aware of which digital technologies are relevant. The business has not considered how new digital technologies would integrate with and / or replace existing manufacturing systems.	The business has identified and is using relevant digital technologies. The business proactively looks for new digital technologies. New digital technologies integrate fully with and / or replace legacy manufacturing systems.
Processes to optimize use of digital	The business does not yet have data policies in place. The business is not set up to capture and share data with suppliers, customers and partners and does not begin collaborative business opportunities.	The business has policies in place for the capture, storage and usage of data, and is able to deal with the reliability and trustworthiness of data. The business is able to use and share data with suppliers, customers and partners and begin collaborative business opportunities.

Table 2 – Characteristics of digital readiness in aspects of manufacturing *(continued)*

Aspect	Weaker digital readiness	Stronger digital readiness
Systems to support digital integration	The business does not have effective support to implement digital technologies. IT and data and information security plans have not been implemented.	Support is available within the business to implement digital technologies. The business is able to evidence implementation of IT and data and information security solutions.
Collaboration with external partners on digital alignment	The business works independently and does not collaborate with customers, suppliers and partners in relation to adopting digital technologies. The business does not assess and manage risk and has not considered the impact of changes to the business model. The business has not considered how information will be managed and governed.	The business works together with customers, suppliers and partners to understand appropriate digital technologies, requirements and impact. The business fully assesses and manages risk and evaluates and tests the impact of new business models. The business has established formal information management standards and information governance arrangements.
Skills to exploit digital	The business does not prioritize digital literacy in the business. Knowledge is held (if at all) by a limited number of individuals. Recruitment processes do not take experience of digital technologies into consideration.	The business proactively invests in training and personal development. The business seeks to recruit people who are literate in digital technologies. The business has strong knowledge-sharing processes in place.
Workforce performance management with digital	The business does not have accurate performance data and / or does not make this readily available to workers. Workforce management is subjective and based on judgement and experience rather than on data.	The business provides workers with access to relevant performance data for their business unit. Workers can identify the impact of their actions within the data. Workforce performance is managed objectively using data that is made available through digital technologies.
Operational performance with digital	The business does not have enough data and is not able to respond quickly to production changes. Performance improvement activity is human led and based on judgement and experience rather than on data.	The business is agile and responsive using digital technologies to automate data collection. Data supports real-time changes and optimizes operational performance. The business leverages new digital technologies to maximize equipment productivity and utilization.
External partner performance with digital	The business has stand-alone manufacturing processes and is not able to offer customers flexibility and customization. After-sales customer engagement is limited. The business does not assess the digital capabilities of partners.	The business relates to customers and suppliers enabling on-demand customer-driven manufacturing processes. Digital technologies support ongoing after-sales customer engagement and upgrades. The business actively assesses and monitors the digital capabilities of its partners.

4.3 Commentary on digital readiness

4.3.1 Leadership vision for digital

A strong drive for growth and the future prosperity of a business often leads to curiosity about the potential benefits of digital technologies. Inspiration should be sought from studying demonstrators and use cases in all aspects relevant to the business, based on the experiences of other organizations that are similar in some aspect, small or large.

Exploring the use of digital, in collaboration with leaders at all levels of the business, increases digital readiness and provides a strong foundation for innovation using digital technologies. This can extend to relationships with customers, suppliers and partners.

Moving from theoretical potential to actual reality requires proactive engagement from leadership with defined roles and responsibilities for new digital systems and processes. Businesses should ensure that the potential benefits from digital technologies are considered as part of formal business strategy, planning and business case processes.

Metrics should be put in place to measure and monitor return on investment and effectiveness. Incorporating metrics as part of business and personal development objectives and making digital technologies a priority increases digital readiness.

4.3.2 Culture of innovation with digital

Creating an environment within the business that encourages innovation and risk-taking is vital. Removing barriers and allocating resources and budget to enable experimentation with new digital technologies, increase digital readiness and empower workers to look for further improvements and opportunities.

Businesses should communicate their digital strategy and develop performance metrics to test whether new technologies are adding value. Pilots, trials and rapid prototyping are examples of an agile approach that enables new technologies to be introduced earlier and with less fear of failure.

Cross-functional collaboration increases digital readiness and businesses should ensure that internal metrics are consistent and support alignment of objectives. Making investments in multiple areas across the business, along with regular review of investment return, costs and benefits increases digital readiness.

4.3.3 Technology integration with digital

The scope and impact of digital technologies are wide-ranging, as indicated in Table 3. Businesses should plan for the integration of new digital technologies with existing machinery and equipment. The planning process should consider the opportunity to replace or upgrade legacy assets to maximize efficiencies.

Road mapping should be used to test the appropriateness and alignment of digital technologies across all business aspects and to establish the phasing of implementation to manage business risks and opportunities.

4.3.4 Processes to optimize use of digital

Data is the underlying currency of digital technologies. The accurate measurement, reliability and trustworthiness of data are fundamentally important in digitalized manufacturing. Businesses can use data to improve operations, understand core metrics and inform the development of new products and services. Ensuring that adequate and regulatory compliant data policies are in place, covering internal and external collection, storage and usage of data, increases digital readiness.

Digital technologies and the resulting data sharing possibilities are transforming the way organizations collaborate, leading to new business models and growth opportunities. The ability to capture and share relevant data with suppliers, customers and partners is a differentiator and increases digital readiness.

When sharing data and/or information, appropriate governance and information management processes should be put in place and a security-minded approach adopted. See PAS 1085:2018, Clause **11**, for further information.

Businesses with strong digital readiness integrate digital features into products and services and can use customer data to offer additional value add services. The results would be reflected in the contribution of digital products and services to overall revenues.

4.3.5 Systems to support digital integration

Successful implementation of digital technologies requires effective IT support within the business. This includes identification of technical and data requirements; and ensuring availability, access, security and accuracy of data collection. IT support for all business processes, and the implementation and regular review of IT and data and information security plans and solutions increase digital readiness.

When information systems are upgraded, businesses should ensure that existing data can be transferred, and that any relevant standards and models are not compromised.

4.3.6 Collaboration with external partners on digital alignment

Businesses should work together with suppliers, customers and partners to ensure successful integration of digital technologies. Identifying the appropriate technologies, resource and capability requirements and critical activities increases digital readiness.

Businesses should assess and manage potential risks arising from digital technologies, for example developing a data ownership policy to protect data-sharing arrangements and intellectual property rights within digital products and services. Businesses should consider establishing formal information management standards and information governance arrangements as required. Businesses should evaluate the impact of new business models, including costs and potential revenue streams arising.

4.3.7 Skills to exploit digital

Digital technologies do not remove the requirement for human interface. Investing in training and development of existing and new workers to be able to take advantage of digital technologies and promoting knowledge sharing across the business accelerate overall digital literacy in the business and increase digital readiness.

Businesses should identify potential skills requirements and ensure that recruitment and training programmes address any gaps. Adoption of digital technology might also create new roles within the business. Recruitment processes should ensure that experience with digital technologies is taken into consideration. Developing skills and experience in digital systems, technologies and processes across the business increases digital readiness.

4.3.8 Workforce performance management with digital

Digital technologies facilitate the availability of accurate real-time data across the business. Communicating key performance information to workers and encouraging them to use digital technologies to support continuous improvement increase digital readiness.

Businesses can use digital technologies to help workers to be more effective and achieve labour productivity improvements. Workers can use digital technologies to understand the impact of their actions and can be managed objectively based on accurate and verified data, removing ambiguity and human bias.

4.3.9 Operational performance with digital

Digital technologies can radically transform business models and the underlying operational functions within a business. Availability of data across networks enables early visibility and rapid responses to faults and problems in the supply chain. Machine-learning and algorithms provide the data and decision-making to support increased efficiency, productivity and utilization of equipment, as well as to undertake preventative maintenance.

Using data to support all operational processes and decision-making increases digital readiness. Controlling machines and systems through automation and using digital modelling and self-optimizing processes increase digital readiness.

4.3.10 External partner performance with digital

Digital technologies enable manufacturing processes to become customer driven, offering increased flexibility, customization and on-demand manufacturing. This can also extend to after-sales activity, with products enabled to facilitate customer upgrades and modifications using digital technology.

Increased connectivity with supplier and customers is providing better visibility of demand and inventories enabling real-time changes to production and customization. Integrating systems and sharing real-time information with suppliers and customers increase digital readiness.

4.4 Evidence of getting ready for digital transformation

Table 3 provides examples of ways in which a business could get ready for digital transformation, including research, collaboration and business processes.

Table 3 – Evidence of getting ready for digital transformation

Recommendation/ Aspect	Methods/ Examples
Leadership vision for digital	• Studying use cases • Studying demonstrators • Collaborating with customers, suppliers and partners • Proactively engaging leadership • Defining roles and responsibilities • Formalizing business strategy, planning and business case processes • Incorporating metrics • Agreeing personal development objectives • Measuring performance • Monitoring return on investment
Culture of innovation with digital	• Encouraging risk-taking • Removing barriers and permitting experimentation • Empowering the workforce • Communicating cross-business strategy • Being agile in the use of digital technologies • Collaborating across functions • Investing across the business
Technology integration with digital	• Planning for integration with existing machinery and equipment • Roadmapping to test cross-business appropriateness, alignment and phasing
Processes to optimize use of digital	• Complying with data regulations • Using digital technologies to support collaboration • Developing new business models enabled by digital technologies • Integrating digital features into products and services
Systems to support digital integration	• Ensuring effective IT systems support for operational improvements • Ensuring and verifying secure and efficient data transfer
Collaboration with external partners on digital alignment	• Collaborating with suppliers and customers and other partners for successful integration of digital technologies • Evaluating the business case for new business models
Workforce skills to exploit digital	• Investing in training in digital skills • Promoting knowledge sharing • Recruiting and training to address skills gaps
Workforce performance management with digital	• Communicating key performance information • Enabling the workforce to work smarter • Managing workforce performance objectively
Operational performance with digital	• Driving continuous improvement in business operational performance by adopting appropriate digital technologies
External partner performance with digital	• Driving continuous improvement in external partner performance by adopting appropriate digital technologies in the business and enabling partners to take advantage of them

5 Measuring digital readiness

5.1 General

Clause **5** sets out how manufacturing businesses should measure their maturity in optimizing their use of digital technologies. A summary of recommendations is presented in Table 4.

Table 4 – Summary of recommendations for measuring digital readiness

Evidence of digital readiness in manufacturing	• Identifying objective and subjective sources of evidence of digital readiness • Benchmarking digital readiness between parts of a business and against similar organizations
Measuring digital readiness consistently	• Measuring digital readiness on a scale of 1 to 9 • Ensuring that digital readiness can be interpreted consistently within the business and externally • Where necessary translating the outputs into a nine-point scale of digital readiness to facilitate read-across
Managing uncertainty in estimating digital readiness	• Ensuring accuracy of measurement of data • Understanding the extent of unmeasured performance • Appreciating limitations in the experience of personnel • Identifying the potential for "unknown unknowns" • Identifying the potential for "optimism bias" • Identifying the potential for "pessimism bias"

5.2 Evidence of digital readiness

Table 5 gives examples of sources of measured data, personal opinions and inter-business comparisons that should be considered and combined in order to understand digital readiness.

Table 5 – Examples of subjective and objective evidence of digital readiness

	Subjective evidence	Objective evidence
Definition	Information based on personal experience, assumptions, opinions or beliefs	Information based on data analysis, measurement or observation
Examples	• Employee satisfaction rating • Customer satisfaction rating • Peer-judged award for excellence in digital manufacturing	• Overall equipment effectiveness • Order to fulfilment time • In-service cost • Performance compared with industry benchmarks

5.3 Estimating digital readiness

Digital readiness, the maturity of a business or part of a business in optimizing its use of digital technologies, should be measured on a scale of 1 to 9. This system of measurement is consistent with other widely adopted manufacturing maturity assessments. Consistent use of a nine-point scale would support efficient read-across and monitoring of digital readiness on a national, regional, sectoral or group basis.

The highest level of digital readiness should represent the optimized state of maturity for a particular business to use digital technologies, given the market and operational circumstances of that business.

Businesses should use this nine-point scale consistently to ensure that digital readiness can be interpreted across all aspects of interest, between parts of a business and with other organizations including external partners. When using digital readiness diagnostic tools with a different scale of measurement, the business should translate the outputs into a common nine-point scale of digital readiness.

Table 6 illustrates a nine-point scale of digital readiness suitable for use with all available evidence including objective and subjective sources.

Table 6 – Typical characteristics of digital readiness defined by a nine-point scale

Level of digital readiness	Characteristics of digital readiness within business	Characteristics of digital readiness of business from outside
9 Highest	Digital technologies are driving optimized productivity and competitiveness for the business and its partners	The business is regarded as an exemplar for its use of digital technologies and is an accessible demonstrator site for customers, suppliers and peers
8	Increasing adoption of digital technologies is sustained by reinvestment of related profits and continuous renewal of the business case	The business, suppliers and customers are co-investing in digital technologies for mutual benefit
7	Innovation with digital technologies is part of the culture of the business and is driving continuous improvement in all aspects	Suppliers and customers are continuously improving their operations with digital technologies aligned with those of the business
6	Digital technologies are driving continuous improvement in key aspects of operational performance including supply chain and customer services	Suppliers and customers are engaged and benefitting from the use of digital technologies with the business
5	Workers are engaged in digital transformation and the business is starting to achieve business case benefits	Suppliers and/or customers are engaged with the business in implementing its digital technologies
4	The business has a strategic vision for digital transformation, the business case is agreed and implementation is underway	The business is engaging with suppliers and/or customers to plan and implement digital technologies for mutual benefit
3	The business is learning from local trials of digital technologies and leaders are investigating the business case	The business is presenting itself to suppliers and/or customers as being keen to improve using digital technologies
2	Workers are aware of the potential for digital technologies and are supported by the business to experiment with local trials	Workers are discussing the use of digital technologies with their supplier or customer counterparts
1 Lowest	The business has no vision for driving growth with digital technologies, and is not supporting workers to investigate opportunities	There is no engagement between the business and suppliers or customers about using digital technologies

5.4 Managing uncertainty in estimating digital readiness

Uncertainty is a factor in the diagnosis of digital readiness as it would be with any evidence relied on in a strategic investment decision. To ensure that businesses' assessment of digital readiness is robust, they should consider:

- accuracy of measurement of data, including the reliability and trustworthiness of sensors and data capture processes;
- verification of evidence of digital readiness from other sources and types of information;
- extent of business process performance that goes unmeasured by intent or by omission;
- breadth and depth of experience of personnel in the use of digital technologies as well as the manufacturing context into which the digital technologies are to be integrated;
- potential for "unknown unknowns" – the information that the business is unaware that it needs;
- potential for "optimism bias" in estimating digital readiness, especially by those directly responsible for the business processes in question; and
- potential for "pessimism bias" in estimating digital readiness, especially by those who might be blockers of innovation with digital technologies.

6 Selecting digital readiness diagnostic tools

6.1 General

Clause **6** sets out the factors that manufacturing businesses should consider when selecting digital readiness diagnostic tools. A summary of recommendations is presented in Table 7.

Table 7 – Summary of recommendations for selecting digital readiness diagnostic tools

Appropriateness of digital readiness diagnostic tools to business needs	Selecting a tool appropriate to business needs
Compatibility between digital readiness diagnostic tools	When more than one tool is used – ensuring compatibility in terms of styles of data entry and reporting, a single source of data, read-across between tools and consistency of definitions, algorithms and measurements
Data and information security	Adopting PAS 1085 specifications for establishing and implementing a security-minded approach

6.2 Appropriateness of digital readiness diagnostic tools to business needs

Many different digital readiness diagnostic tools have been developed by practitioners for a range of purposes relevant to manufacturing businesses. Each of these tools has its own scale of digital readiness and its own measurement system. Such tools are often specialized in terms of the aspects of a business they are intended to examine.

Annex A lists several digital readiness diagnostic tools that have been developed with some element of UK government funding and are available free of charge (at the time this PAS was published).

Businesses should ensure that they select digital readiness diagnostic tools appropriate to their evolving objectives. Table 8 indicates that tools focused on different aspects of the business might be required at different times to support cross-business strategy for driving value from digital technologies and also aspect-specific business needs.

Table 8 – Scopes of cross-business and aspect-specific digital readiness diagnostic tools

Scope of tool	Cross-business digital readiness			
All aspects of business	Maturity of business to achieve long-term strategic business objectives with digital technologies			
	Aspect-specific digital readiness			
Leadership	Maturity of leadership vision for digital		Maturity of culture of innovation with digital	
Technology enablers	Maturity of technology integration with digital	Maturity of processes to optimize use of digital	Maturity of systems to support digital integration	Maturity of collaboration with external partners on digital alignment
Workforce results	Maturity of skills to exploit digital		Maturity of workforce performance management with digital	
Operational results	Maturity of operational performance with digital			
Partner results	Maturity of external partner performance with digital			

6.3 Compatibility between digital readiness diagnostic tools

When it is necessary to use more than one digital readiness diagnostic tool to improve clarity cross-business and/or in multiple aspects, a business should consider the compatibility of the tools in terms of:

- styles of data entry and reporting;
- management of a single source of data, and avoidance of double-entry of data;
- consistency of definitions of business aspects and associated digital readiness;
- ability to "read-across" the digital readiness diagnosed by different tools; and
- consistency of algorithms and measurement of digital readiness.

6.4 Data and information security

Information security management is a vital consideration in the selection and use of a digital readiness diagnostic tool when data is to be stored on an organization's systems or externally, and when data is to be shared between workers and organizations.

Insecure storage, transmission, processing or use of data and information may have a number of consequences, including loss of intellectual property, interference with business and manufacturing processes, loss of personal data, and financial, economic or reputational harm to the organization and/or its customers. Guidance on a security-minded approach for manufacturing and addresses technological security can be found in PAS 1085:2018, **11.4**.

Technology-specific requirements are set out for example in PAS 7040:2019 [1)], which considers security-minded deployment of networked sensors.

[1)] In preparation, at the time of publication.

7 Using digital readiness diagnostic tools

7.1 General

Clause **7** sets out how manufacturing businesses should use digital readiness diagnostic tools in optimizing their use of digital technologies. A summary of recommendations is presented in Table 9.

NOTE *These guidelines do not provide a complete methodology for planning or implementation of digital technologies.*

Table 9 – Summary of recommendations for using digital readiness diagnostic tools

Appreciating business potential to improve	• Initializing a vision of what can be achieved with digital technologies • Initializing discussion of potential benefits of digital technologies, and the influence of specific circumstances and market conditions
Understanding digital readiness and gaps to be addressed	• Measuring the difference between optimized use of digital technologies and actual digital readiness • Identifying gaps to be addressed
Identifying actions needed to address gaps	• Identifying actions to move towards optimized use of digital technologies • Understanding dependencies between actions across the business • Clarifying availability of funding and resources • Understanding the optimum sequencing of activities • Recognizing the need for targets for improved performance
Setting targets for improved performance	• Setting targets for each aspect influencing the business case • Targeting optimized performance across the business in the context of market opportunities, costs of capability development and changes in operations and external relationships, and benchmarks achieved by other businesses
Monitoring progress towards targets	• Keeping track of developing digital readiness and progress towards business goals • Being consistent in the use of digital readiness diagnostic tools • Keeping records • Providing ready and secure access to digital readiness data • Monitoring completion of actions • Managing changing priorities across the business

7.2 Appreciating business potential to improve

Businesses should expect digital readiness diagnostic tools to present through their questions an initial vision of what could be achieved by the business using digital technologies. As indicated in Table 3, the characteristics of stronger use of digital technologies should encourage discussion of what could be optimal in each aspect of the business. The potential for businesses to improve is related to the difference between the optimized use of digital technologies and their actual digital readiness. However, businesses should understand that their potential to improve and the nature of their optimized digital readiness depends on their specific circumstances and market conditions.

7.3 Understanding digital readiness and gaps to be addressed

Businesses should expect digital readiness diagnostic tools to measure the difference between optimized use of digital technologies and their actual digital readiness. Digital readiness diagnostic tools should enable through their questions identification of the gaps to be addressed in each aspect of the business in order to achieve optimized digital readiness.

7.4 Identifying actions needed to address gaps

Businesses should expect digital readiness diagnostic tools to present through their questions a vision of the actions that would be needed to optimize their use of digital technologies. However, businesses should understand that the actions they take to improve depends on their specific circumstances and market conditions, and hence they should consider factors such as:

- dependencies between actions;
- availability of funding and resources;
- optimum sequencing of activities; and
- targets for improved performance.

7.5 Setting targets for improved performance

The extent to which a business should aim to improve its digital readiness depends on the economic, financial and wider business case for investment. Businesses should set targets for improvements in digital readiness in specific aspects according to strategic priorities. Targets should be set for each aspect that would influence the business achieving the results anticipated by its business case. The digital readiness target should be the optimum for the business, considering factors such as:

- number and scale of market opportunities for new contracts and retention of existing business with the benefit of digital technologies;
- costs of developing new capabilities that include the use of digital technologies, including assets and changes in working practices;
- changes in costs of operations that include the use of digital technologies;
- changes in costs of relationships with external partners that include the use of digital technologies, such as a shift to services; and
- digital readiness benchmarks for comparable businesses, by sector and size and other factors.

7.6 Monitoring progress towards targets

Businesses should keep track of progress towards achieving business case goals by monitoring digital readiness, considering:

- consistent use of chosen digital readiness diagnostic tools to track progression of digital readiness over time;
- record-keeping, tracking changes in evidence and in digital readiness;
- ready and secure access to digital readiness data by those responsible for actions relating to digital transformation;
- monitoring completion of actions and reducing gaps identified from previous digital readiness diagnostic tools;
- monitoring progress towards achieving business case results; and
- managing changes in priorities across the business.

Annex A (informative)
Digital readiness diagnostic tools

A.1 4Manufacturing®[2)]

https://ktn-uk.co.uk/programmes/4manufacturing

4Manufacturing® is a free-to-use diagnostic tool with support framework that helps manufacturers to deploy digital technologies and realize the "fourth industrial revolution" (Industry 4.0). 4Manufacturing® was developed by the Knowledge Transfer Network (KTN) in partnership with industry.

4Manufacturing® provides support from trained advisers who work with industry to:

- understand needs and identify opportunities;
- define and follow a step-by-step balanced plan of action;
- start with small improvements and grow capability and confidence;
- make targeted links to enablers and funding; and
- deliver tangible benefits.

A.2 Digital Readiness Level™ Tool[2)]

https://www.drl-tool.org

The Digital Readiness LevelTM Tool (DRL Tool) is a free-to-use secure online resource developed and maintained by a not-for-profit cross-industry consortium of manufacturing and technology experts including the High Value Manufacturing Catapult, the Digital Catapult, the Knowledge Transfer Network (KTN), Hennik Research Ltd (The Manufacturer), EDGE Digital Manufacturing Limted and HSSMI Limited.

The DRL Tool is a digital readiness diagnostic and benchmarking tool that deals with all key aspects of the business of manufacturing, including leadership, culture of innovation, technology, processes, systems, collaboration with external partners, skills, workforce performance management, operational performance, and external partner performance.

Users of the DRL Tool have control of their data and can choose to share it securely with colleagues and partners. They can benchmark the digital readiness of their organisation at a given time against similar businesses, and they can track progress in digital readiness in the course of adopting digital technologies.

A.3 Supply Chains in Practice Industry 4 readiness assessment tool

https://warwick.ac.uk/fac/sci/wmg/research/scip/industry4report/

An Industry 4 readiness assessment survey tool has been developed by WMG, the University of Warwick, in conjunction with Crimson & Co and Pinsent Masons.

This survey is a maturity assessment of a company's "readiness and future ambition to harness the potential of the new cyber-physical age". The survey has six parts: product and service; manufacturing and operations; strategy and organization; supply chain; business model; and legal considerations.

Using a paper template or online, users complete a self-assessment of a company's current Industry 4 readiness. The results are benchmarked against a group of companies.

A.4 Manufacturing 4.0 Review

https://www.scottish-enterprise.com/support-for-businesses/develop-products-and-services/support-for-manufacturers

Scottish Enterprise has developed an Industry 4 review, which is delivered by the Scottish Manufacturing Advisory Service (SMAS). The Manufacturing 4.0 Review is a comprehensive assessment of a manufacturing business aimed at identifying current status and future targets. It provides an aligned approach towards carefully considered investment decisions to adopt digital technologies in the business.

The Manufacturing 4.0 Review comprises two days fully-funded support which is delivered by SMAS practitioners and digital specialists. The first stage of the review uses a diagnostic tool to identify strengths and opportunities in six key thematic areas.

[2)] 4Manufacturing® and Digital Readiness Level™ Tool are examples of suitable products available. This information is given for the convenience of users of this document and does not constitute an endorsement by BSI of these products. Equivalent products may be used if they can be shown to lead to the same results.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAS 1085:2018, *Manufacturing — Establishing and implementing a security-minded approach — Specification*

Other publications and websites

[1] HM GOVERNMENT. The UK's Industrial Strategy. London: HM Government, 2017.[3)]

[2] HM GOVERNMENT. Made Smarter Review 2017. London: HM Government, 2017.[4)]

[3] WORLD ECONOMIC FORUM. Digital Transformation Initiative. Switzerland: World Economic Forum, 2018.[5)]

[4] OFFICE FOR NATIONAL STATISTICS. Manufacturing and production industry data. London: Office for National Statistics, 2019.[6)]

Further reading

BS 7799-3:2017, *Information security management systems — Part 3: Guidelines for information security risk management (revision of BS ISO/IEC 27005:2011)*

BS 13500:2013, *Code of practice for delivering effective governance of organizations*

BS 31111:2018, *Cyber risk and resilience — Guidance for the governing body and executive management*

BS ISO/IEC 19086-4:2019, *Cloud computing — Service level agreement (SLA) framework — Part 4: Components of security and of protection of PII*

ISO 18828-5:2019, *Industrial automation systems and integration — Standardized procedures for production systems engineering — Manufacturing change management*

PAS 7040:2019, *Digital manufacturing — Trustworthiness and precision of networked sensors — Guide* [7)]

[3)] Available from: www.gov.uk/government/topical-events/the-uks-industrial-strategy
[4)] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/655570/20171027_MadeSmarter_FINAL_DIGITAL.pdf
[5)] Available from: http://reports.weforum.org/digital-transformation/
[6)] Available from: www.ons.gov.uk/businessindustryandtrade/manufacturingandproductionindustry
[7)] In preparation, at the time of publication.

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards-based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Relations
Tel: +44 345 086 9001
Email: cservices@bsigroup.com

Subscription Support
Tel: +44 345 086 9001
Email: subscription.support@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI, 389 Chiswick High Road
London W4 4AL
United Kingdom
www.bsigroup.com

9 780539 035407