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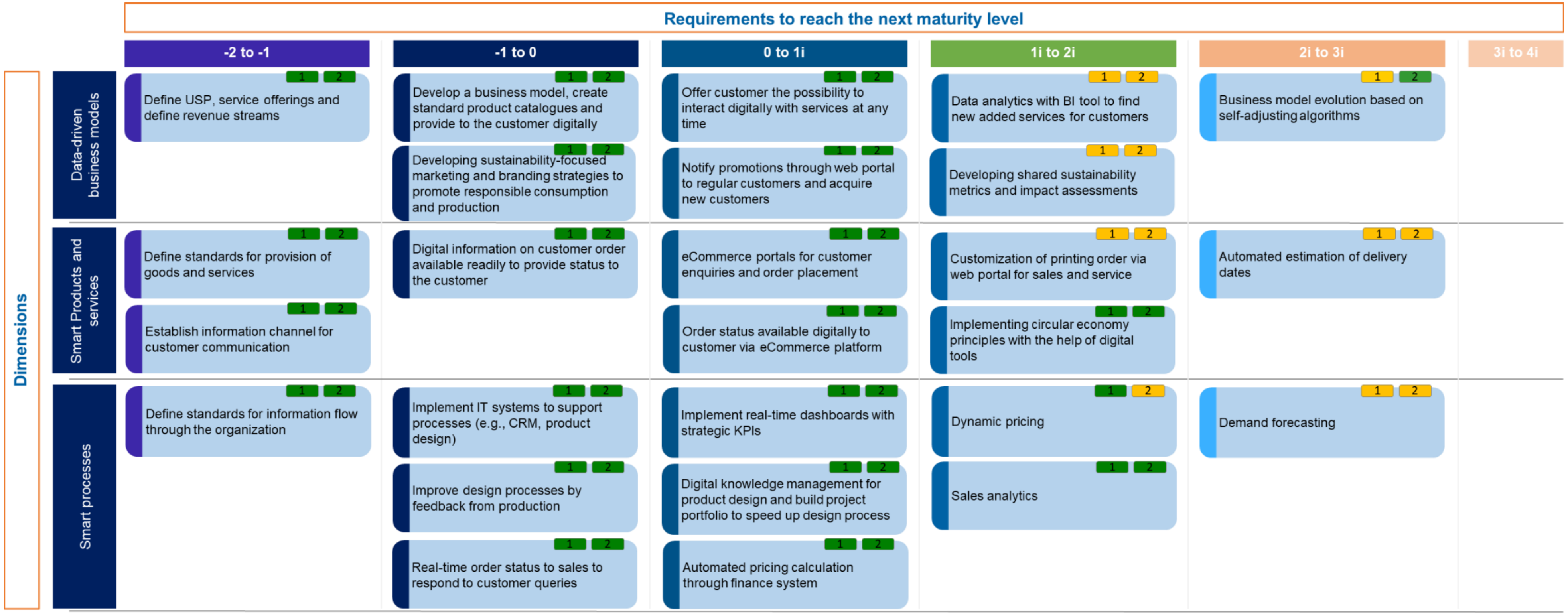
“Print 4.0” Upgrading Blueprint: Roadmap for the Printing Industry

Roadmap including use cases for step-by-step transformation towards Print 4.0

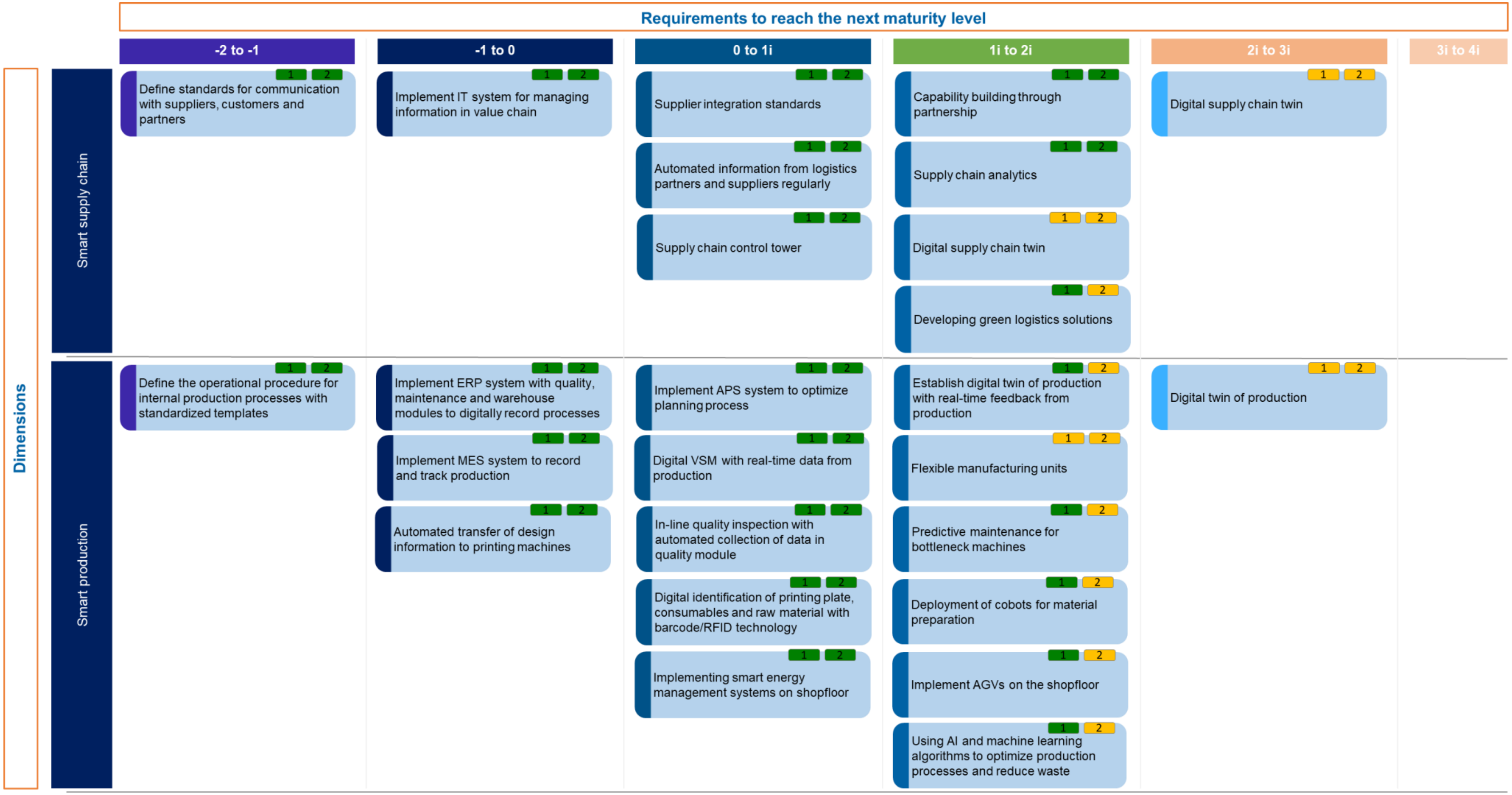


Requirements to reach the next maturity level

Dimensions	-2 to -1	-1 to 0	0 to 1i	1i to 2i	2i to 3i	3i to 4i
Data-driven business models	Define USP, service offerings and define revenue streams 1🟩 2🟩	Develop a business model, create standard product catalogues and provide to the customer digitally 1🟩 2🟩 Developing sustainability-focused marketing and branding strategies to promote responsible consumption and production 1🟩 2🟩	Offer customer the possibility to interact digitally with services at any time 1🟩 2🟩 Notify promotions through web portal to regular customers and acquire new customers 1🟩 2🟩	Data analytics with BI tool to find new added services for customers 1🟨 2🟨 Developing shared sustainability metrics and impact assessments 1🟨 2🟨	Business model evolution based on self-adjusting algorithms 1🟨 2🟩	
Smart Products and services	Define standards for provision of goods and services 1🟩 2🟩 Establish information channel for customer communication 1🟩 2🟩	Digital information on customer order available readily to provide status to the customer 1🟩 2🟩	eCommerce portals for customer enquiries and order placement 1🟩 2🟩 Order status available digitally to customer via eCommerce platform 1🟩 2🟩	Customization of printing order via web portal for sales and service 1🟨 2🟨 Implementing circular economy principles with the help of digital tools 1🟩 2🟩	Automated estimation of delivery dates 1🟨 2🟨	
Smart processes	Define standards for information flow through the organization 1🟩 2🟩	Implement IT systems to support processes (e.g., CRM, product design) 1🟩 2🟩 Improve design processes by feedback from production 1🟩 2🟩 Real-time order status to sales to respond to customer queries 1🟩 2🟩	Implement real-time dashboards with strategic KPIs 1🟩 2🟩 Digital knowledge management for product design and build project portfolio to speed up design process 1🟩 2🟩 Automated pricing calculation through finance system 1🟩 2🟩	Dynamic pricing 1🟩 2🟨 Sales analytics 1🟩 2🟩	Demand forecasting 1🟨 2🟨	

Legend:

1 Technology Maturity
2 Economic Feasibility
🟩 High
🟨 Medium
🟥 Low



Requirements to reach the next maturity level

Dimensions	-2 to -1	-1 to 0	0 to 1i	1i to 2i	2i to 3i	3i to 4i
Smart supply chain	Define standards for communication with suppliers, customers and partners 🟩1 🟩2	Implement IT system for managing information in value chain 🟩1 🟩2	Supplier integration standards 🟩1 🟩2 Automated information from logistics partners and suppliers regularly 🟩1 🟩2 Supply chain control tower 🟩1 🟩2	Capability building through partnership 🟩1 🟩2 Supply chain analytics 🟩1 🟩2 Digital supply chain twin 🟨1 🟨2 Developing green logistics solutions 🟩1 🟨2	Digital supply chain twin 🟨1 🟨2	
Smart production	Define the operational procedure for internal production processes with standardized templates 🟩1 🟩2	Implement ERP system with quality, maintenance and warehouse modules to digitally record processes 🟩1 🟩2 Implement MES system to record and track production 🟩1 🟩2 Automated transfer of design information to printing machines 🟩1 🟩2	Implement APS system to optimize planning process 🟩1 🟩2 Digital VSM with real-time data from production 🟩1 🟩2 In-line quality inspection with automated collection of data in quality module 🟩1 🟩2 Digital identification of printing plate, consumables and raw material with barcode/RFID technology 🟩1 🟩2 Implementing smart energy management systems on shopfloor 🟩1 🟩2	Establish digital twin of production with real-time feedback from production 🟩1 🟨2 Flexible manufacturing units 🟨1 🟨2 Predictive maintenance for bottleneck machines 🟩1 🟨2 Deployment of cobots for material preparation 🟩1 🟨2 Implement AGVs on the shopfloor 🟩1 🟨2 Using AI and machine learning algorithms to optimize production processes and reduce waste 🟩1 🟨2	Digital twin of production 🟨1 🟨2	

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Requirements to reach the next maturity level

Dimensions	-2 to -1	-1 to 0	0 to 1i	1i to 2i	2i to 3i	3i to 4i
Smart technologies	🟩1 🟩2 Use of computer applications for managing processes	🟩1 🟩2 Use of digital collaboration tool for internal communication 🟩1 🟩2 Set up basic IT Infrastructure with WiFi/Internet coverage 🟩1 🟩2 Machine interfaces to interact with machines	🟩1 🟩2 Retrofitting of legacy machines and automation of manual manufacturing processes 🟩1 🟩2 Set standards for connecting edge devices with IoT platform for real-time data collection 🟩1 🟩2 Set up IoT center to centrally collect data from machines 🟩1 🟩2 Digital dashboards and scanners to record and display orders at work stations 🟩1 🟩2 Using IoT sensors to monitor resource usage, such as water or electricity	🟩1 🟩2 Develop single source of truth 🟩1 🟩2 Set up BI tool		
Strategy and organization	🟩1 🟩2 Define IT governance framework	🟩1 🟩2 Establish Lean approach starting with 5S methodology	🟩1 🟩2 Build digital strategy based on company goals 🟩1 🟩2 Formulate cross-functional teams for driving digital strategy	🟩1 🟩2 Implement data governance framework 🟩1 🟩2 Set up continuous improvement teams 🟩1 🟩2 Qualify employees to handle and analyse data		
Culture and mindset	🟩1 🟩2 Create mindset for compliance to the standard procedures	🟩1 🟩2 Create awareness for usage of IT systems and importance of data	🟩1 🟩2 Promote cross-departmental knowledge transfer 🟩1 🟩2 Integrating sustainability into a digital strategy	🟩1 🟩2 Develop agile working culture 🟩1 🟩2 Enable data-driven decision making		

Legend: 1 Technology Maturity; 2 Economic Feasibility; 🟩 High; 🟨 Medium; 🟥 Low

Print 4.0 Use Cases and Applications

More information on the advantages of each pilot project on the roadmap, along with a description of the particular use case or application. The description of dimension is as follow:

1. **Data Driven Business Models** - Defining value proposition and revenue model using data
2. **Smart Products and Services** - Additional value for direct or end-customer
3. **Smart Processes** - Internal information flow for non-physical processes
4. **Smart Supply Chain** - Information flow with partners, suppliers and customers
5. **Smart Production** - internal material & information flow for processes with physical counterpart
6. **Smart Technologies** - technology enablers / Infrastructure
7. **Strategy & Organization** - co-ordination of resources
8. **Culture & Mindset -** co-ordination of mindset / approaches

Level -2 to -1: The first step is the conversion of activities that are primarily Print 3.0 processes from non-digital, highly manual, and paper-based (more ad hoc and chaotic than methodical) operations.

-2 to -1	**Define USP, service offerings and define revenue streams**	1	2
Data-driven business models	USP is widely known - internally and externally, what kind of capabilities do our people, machines have that are valueable to customers, what brings us profit, setting pricing model etc.		

-2 to -1	**Define standards for provision of goods and services**	1	2
Smart Products and Services	Defining how services are provided to the customer, standard procedure for how customer requests will be processed. This can ensure that customers receive a consistent and high-quality experience. This can help to improve customer satisfaction, build loyalty, and ultimately drive business growth.		

-2 to -1	**Establish an information channel for customer communication**	1	2
Smart Products and Services	Define standards for how customer communications will occur and how they will be further processed, creating standard templates for offers, defining lead times for answering customer requests and processing quotations.		

-2 to -1	**Define standards for information flow through the organization**	1	2
Smart processes	Defining which departments are responsible for each internal process, what information needs to be made available to relevant departments and setting standards for information availability and channels of communication.		

-2 to -1	**Define standards for communication with suppliers, customers and partners**	1	2
Smart supply chain	Defining standards for communication in supply network, SOP for interaction with partners, suppliers and customers, creating templates for supplier orders, reduce miscommunication and delay in information transfer in the supply chain.		

-2 to -1	**Define the operational procedure for internal production processes with standardized templates**	1	2
Smart Production	Define SOP for shopfloor activites, roles and responsibilites are clearly known to all, how commercial information and information about adjacent processes are communicated - e.g., urgencies, high value orders, etc., and use standard templates for information transfer.		

-2 to -1	**Use of computer applications for managing processes**	1	2
Smart Technologies	No more physical documentation and moving from paper-based processes to use of computer-based applications to record and store information, information is not stored as papers in folders, but in digital format so that it can be easily retrieved.		

-2 to -1	**Define IT governance framework**	1	2
Strategy & organisation	Set guidelines and standards for IT framework, strategic alignment of IT framework with the corporate strategy. Company can ensure that its IT resources are aligned with its business goals and objectives. This can help to improve the overall efficiency and effectiveness of the organization, resulting in increased productivity, reduced costs, and improved customer satisfaction.		

-2 to -1	**Create mindset for compliance to the standard procedures**	1	2
Culture & mindset	Create awareness about why standardization is important, promote culture of adherence to standard operating procedures and need to follow defined processes. Especially for those company want to improve their efficiency, reduce waste, and enhance the quality of their products or services. By standardizing processes, organizations can improve productivity, reduce costs, enhance safety, and promote consistency. Moreover, standardization can help to create a culture of continuous improvement, where processes are regularly reviewed and refined to ensure that they remain effective and efficient over time		

Level -1 to 0: Basic systemization of operations is carried out, along with rudimentary digitization and the installation of standalone IT systems for automating specific jobs or processes. By implementing the following steps, the next stage with links to internal IT systems without media breaks can be reached.

-1 to 0	**Develop a business model, create standard product catalogues and provide to the customer digitally**	1	2
Data-driven business model	Make customers aware of what standard products are available and also what customization is possible, plan marketing roadmap to make it visible to target customers. By digitizing this, it can help increasing its sales, improve customer satisfaction, and enhance its brand reputation.		

-1 to 0	**Developing sustainability-focused marketing and branding strategies to promote responsible consumption and production**	1	2
Data-driven business model	By developing sustainability-focused marketing and branding strategies, businesses can build a reputation as a responsible and sustainable brand, attract environmentally conscious customers, and contribute to the achievement of sustainable development goals.		
-1 to 0	**Digital information on customer order available readily to provide status to the customer**	1	2
Smart Products and Services	All needed information about customer order is available readily to the sales or customer management team to provide the customer quick and assured information about the current status of their ongoing order		
-1 to 0	**Implement IT systems to support processes (e.g., CRM, product design)**	1	2
Smart processes	Providing digital tools to employees to support them in their functions and better manage their tasks and record information. Employees and company can benefit from improving efficiency, increasing productivity, enhancing the quality of products or services, improving collaboration and communication, and attracting and retaining top talent		
-1 to 0	**Improve design processes by feedback from production**	1	2
Smart processes	Generate a feedback loop to fasten the product design functions by providing the sampling and design department with the information on changes of the parameters on shopfloor so that it can be used for repeating orders and reduce time required for design approval process		
-1 to 0	**Real-time order status to sales to respond to customer queries**	1	2
Smart processes	For new enquiries, overview to the sales about the internal capacities, material availability so that they can provide guaranteed information to the customer about the delivery deadline without having to call/send paper-based request to manufacturing thus reducing response time to customer		
-1 to 0	**Implement IT system for managing information in value chain**	1	2
Smart Supply Chain	Assess the need of IT tools or modules of ERP system where supply chain data can be managed and suppliers can be integrated. This can create a horizontal integration and improve supply chain visibility, reduce costs and enhance supplier collaboration.		
-1 to 0	**Implement ERP system with quality, maintenance and warehouse modules to digitally record processes**	1	2
Smart Production	Implement ERP system to record and manage core business processes, either separate systems or add-on modules for managing quality, maintenance and warehouse modules to get an overview of processes and manage it digitally		

-1 to 0	**Implement MES system to record and track production**	1	2
Smart Production	MES system that integrates with ERP, record all production relevant data and capture production times, production history, ongoing manufacturing orders and thus get an overview of capacities and production efficiency		

-1 to 0	**Automated transfer of design information to printing machines**	1	2
Smart Production	Customer approved design can be automatically transferred to the printing machine via suitable interfaces to avoid any delays in machine set-up times. This can help to ensure the final products meets their requirements and expectation.		

-1 to 0	**Use of digital collaboration tool for internal communication**	1	2
Smart Technologies	Eliminate communication via emails and phone calls and enable efficient communication between departments and all relevant people so that discussions occur faster and decisions are not delayed		

-1 to 0	**Set up basic IT Infrastructure with WiFi/Internet coverage**	1	2
Smart Technologies	A good IT infrastructure necessary to enable implementation of softwares and machine connectivity, build an infrastructure with future projects according to the roadmap in mind. This create the framework of vertical and horizontal integration to ensure the connectivity of each system.		

-1 to 0	**Machine interfaces to interact with machines**	1	2
Smart Technologies	Machines have standard interfaces that helps the operator to interact with the machine on the shopfloor and enter or change machine settings. This enhance the operator’s ability to control the machine, improving training and knowledge transfer and ultimately improving safety during operation of machine.		

-1 to 0	**Establish Lean approach starting with 5S methodology**	1	2
Strategy & Organization	Start implementation of lean values to reduce waste and organize the shopfloor with defined areas for optimized flow of material reducing transportation times. The defined area can also isolate the flow of material without interuption which result improving efficiency		

-1 to 0	**Create awareness for usage of IT systems and importance of data**	1	2
Culture & Mindset	Inform the employees the importance of data and how it can help to drive improvement, IT systems are tools for supporting employees in their tasks should be known to all to avoid any workarounds, accepting technology for benefit of individual and company		

Level 0 to 1i: The following level provides seamless, real-time information flow between internal and external information sources and IT systems in all directions. One of the key responsibilities at this level is to establish a "single source of truth" and more transparency across all processes and activities.

0 to 1i	**Offer customer the possibility to interact digitally with services at any time**	1	2
Data-driven business model	Providing an online platform where customers can see the services offered, less interaction via emails. As email also involve manual checking in which human error cannot be avoided, online platform can offer 24 hours seamless log to customer in regardless of location.		
0 to 1i	**Notify promotions through web portal to regular customers and acquire new customers**	1	2
Data-driven business model	Information to the customers about new deals and promoting services through website, offers provided digitally to the customers to increase sales. This faciliate the engagment between customer and they can know more precisely about what you can offer		
0 to 1i	**eCommerce portals for customer enquiries and order placement**	1	2
Smart Products and Services	Less waiting time for customers, one single platform for sales team to get customer enquiries and orders, visibility on pending customer rfqs and provide price proposals. By anyalzing their order and activities, sales forecasting can also be avheived.		
0 to 1i	**Order status available digitally to customer via eCommerce platform**	1	2
Smart Products and Services	Customers can see the status of the order via webportal, added service to the customer to increase customer satisfaction. Reducing the back and forth email communication for the order status		
0 to 1i	**Implement real-time dashboards with strategic KPIs**	1	2
Smart processes	Derieve KPIs based on the company strategy and use the data from IT systems to create graphs, make dashboards where the KPIs are tracked and also visible to the management so that they can know the performance of shopflorr equipment and figure out the bottle neck and pain point		
0 to 1i	**Digital knowledge management for product design and build project portfolio to speed up design process**	1	2
Smart processes	Record knowledge of projects digitally and create a knowledge bank of all the projects so that this information can be referred to in the future and optimize design process, preserving intelligence and experience of the employees for company benefit		

0 to 1i	**Automated pricing calculation through finance system**	1	2
Smart processes	Set price models for products and services which will help in automatic price calculation thus reducing the efforts of the employees and fast processing of rfqs. This rapid output enhance the comptivieness in the market and response the customer inquiries more quickly and efficiently		

0 to 1i	**Supplier integration standards**	1	2
Smart supply chain	Set standards for connecting supply chain partners' system with internal IoT platform for automated information. Improving its supply chain visibility, enhance collaboration with partners, and improve operational efficiency		

0 to 1i	**Automated information from logistics partners and suppliers regularly**	1	2
Smart supply chain	Enable automated information flow through integration through APIs so avoid phone calls with suppliers and logistics providers and seamless service without delays. Through system intergration, order can be made automaticaly to aovid shortage of material in the production floor		

0 to 1i	**Supply chain control tower**	1	2
Smart supply chain	Overall visibility on supply chain and central information on where raw materials and finished customer goods are in the transportation channels. Company can better plan and coordinate its supply chain acitivities to reduce lead time, minmize inventory levels.		

0 to 1i	**Implement APS system to optimize planning process**	1	2
Smart Production	APS system will help to manage the complex planning process better by taking all planning rules and restrictions into account and ease the task of planning and optimize the machine utilization and use capacitites to the fullest		

0 to 1i	**Digital VSM with real-time data from production**	1	2
Smart Production	Further implement lean tool of VSM by mapping material and information flow by capturing real-time data from shopfloor with tracking and trace technologies, compare actual cycle times with calculated values and find opportunities for improvement		

0 to 1i	**In-line quality inspection with automated collection of data in quality module**	1	2
Smart Production	Use digital technologies like in-line camera system to test the quality of the print and collection of the digital records in the quality management system or the quality module to prevent quality defects from happening and modifying the process to meet quality standards		

0 to 1i	**Digital identification of printing plates, consummables and raw material with barcode/RFID technology**	1	2
Smart Production	Digitally record all materials needed for production using barcode or RFID technology for quick identification. All the necessaities can be tracked and traced which increase the visibility of inventory.		
0 to 1i	**Implementing smart energy management systems on shopfloor**	1	2
Smart Production	IoT sensors can be placed throughout the shopfloor to monitor energy usage in real-time. These sensors can track electricity consumption, temperature, humidity, and other factors that affect energy usage.		
0 to 1i	**Retrofitting of legacy machines and automation of manual manufacturing processes**	1	2
Smart technologies	Adding sensors to the machines to capture process data, connecting machines to the MES system to record the process without manual input, further automating any manual processes - specially post-printing processes like labelling and packaging		
0 to 1i	**Set standards for connecting edge devices with IoT platform for real-time data collection**	1	2
Smart technologies	Specify machine connectivity and IoT standards with universally acceptable specifications and standards to collect data in real-time. This can ease the vertical system integration and align the latency data follow		
0 to 1i	**Set up IoT center to centrally collect data from machines**	1	2
Smart technologies	Implement cloud solution for central collection of stored data with ability to connect to other business applications. Allowing cloud computing and implmentation of AI algorthirm.		
0 to 1i	**Digital dashboards and scanners to record and display orders at work stations**	1	2
Smart technologies	Use of scanners for automatic recording production start and stop and display of customer orders digitally through work instruction screens eliminating need for paper-based work orders		
0 to 1i	**Using IoT sensors to monitor resource usage, such as water or electricity**	1	2
Smart technologies	By using IoT sensors to monitor resource usage, organizations can improve efficiency and reduce costs. For example, they can identify leaks or inefficiencies in water or electricity usage and take steps to address them.		

0 to 1i	**Build digital strategy based on company goals**	1	2
Strategy & Organization	Define a digital strategy which aligns with company goals and helps to define a roadmap for digitalization projects and drive KPIs. This involves identifying the key business drivers and determining how digital technologies can help to achieve these objectives. For example, if the company's goal is to increase sales, the digital strategy may focus on implementing e-commerce platforms or improving the customer experience through digital channels.		

0 to 1i	**Formulate cross-functional teams for driving digital strategy**	1	2
Strategy & Organization	Usually digital strategy implementation requires cross-departmental people with varied knowledge and capabilites to work together on a common goal with result in improving employee engagement and efficiency towards the goal.		

0 to 1i	**Integrating sustainability into a digital strategy**	1	2
Strategy & Organization	Sustainability and digital strategy are closely linked, as digital technologies can be used to drive sustainability initiatives and promote sustainable practices.E.g., data-driven sustainability for measuring sustainability performance and identify ideas for improvement		
0 to 1i	**Promote cross-departmental knowledge transfer**	1	2
Culture & Mindset	Create a culture where employees from different functions and departments come together and share knowledge and information and work strategically towards improvement of organization		
0 to 1i	**Promote acceptance and usage of data and IT systems**	1	2
Culture & Mindset	Make employees realise the value of data collection and usage and how it can support in continuous improvement. Encouraging employee to take a proactive approach to data management, ensuring the data is accurate, complete, and consistent.		

Level 1i to 2i: To uncover cause-and-effect links between events and their underlying causes, a comprehensive aggregation of internal and external real-time data is sought after with the transition from level 1i to level 2i.

1i to 2i	**Data analytics with BI tool to find new added services for customers**	1	2
Data-driven business model	Explore new markets, increase customer base, find innovative services for customers and know what capabilities will be required to serve future customers with the help of business intelligence tool by analyzing market data and changing customer requests		

1i to 2i	**Developing shared sustainability metrics and impact assessments**	🟨 1	🟨 2
Data-driven business model	By developing shared sustainability metrics and impact assessments, stakeholders within the digital ecosystem can promote sustainability governance and work towards achieving sustainable development goals.		

1i to 2i	**Customization of printing order via web portal for sales and service**	🟨 1	🟨 2
Smart Products and Services	Provide customers the possibility of customizing their orders and see added services through web platforms so that increase the accuracy of the order and provide a better customer service.		

1i to 2i	**Implementing circular economy principles with the help of digital tools**	🟩 1	🟩 2
Smart Products and Services	Prioritize the reduction of waste and the preservation of resources. Digital tools support in transition towards circularity by streamlining processes, reducing material waste, and increasing efficiency. E.g. digital tools can help track the usage of printing materials and ensure they are recycled or repurposed as much as possible.		

1i to 2i	**Dynamic pricing**	🟩 1	🟨 2
Smart Processes	Dynamic price calculation using data analytics that takes into account the seasonality, competition and market demand along with cheapest production method. This can reduce the expense and maximize the profits along each project.		

1i to 2i	**Sales analytics**	🟩 1	🟩 2
Smart Processes	Use of historical data to generate insights on sales turnovers, new marketing campaigns, analyse new product introduction and new customer acquired, etc This can improve sales forcasting and enhance business expansion		

1i to 2i	**Capability building through partnership**	🟩 1	🟩 2
Smart supply chain	Developing partners for missing capabilities, use of analytics to determine future demands by customers and finding partners to enable new services. This improve its competitiveness, enhance its customer experience, and expand its service offerings.		

1i to 2i	**Supply chain analytics**	🟩 1	🟩 2
Smart supply chain	Using real-time information from supply chain to measure supplier performance, data analysis to optimize flow of goods with help of data analytics. Supplier can also be brenchmarked to assist with selection of supplier to improve quality.		

1i to 2i	**Digital supply chain twin**	🟨 1	🟨 2
Smart supply chain	Digital representation of supply chain with real-time input of data to create graphs and visualization to understand the trends and better plan manufacturing. Company can improve its supply chain visibility, enhance decision-making capabilities, and optimize manufacturing processes.		

1i to 2i	**Developing green logistics solutions**	🟩 1	🟨 2
Smart supply chain	This can help ensure that their products are transported in an environmentally friendly way, reducing the environmental impact of the printing industry as a whole. Company can build up their reputation and attract more customers.		

1i to 2i	**Establish digital twin of production with real-time feedback from production**	🟩 1	🟨 2
Smart Production	Simulation-based digital representation of production shopfloor with real-time feedback of data to visualize and control production remotely. Production process can also be simulated to predict the best flow for production.		

1i to 2i	**Flexible manufacturing units**	🟨 1	🟨 2
Smart Production	Flexible printing and post-printing machines or production cells that for quick changeover of products or customer orders. This increase the flexiability to adapt rapid market change.		

1i to 2i	**Predictive maintenance for bottleneck machines**	🟩 1	🟨 2
Smart Production	Monitoring the conditions of machines by using the real-time sensor data to find trends that might lead to breakdown of machines and hinder production. Production balance can be optimzied to reduce downtime of breaking machine.		

1i to 2i	**Deployment of cobots for material preparation**	🟩 1	🟨 2
Smart Production	Use of cobots that work together with the humans for machine tending applications, support logistical processes of warehouse picking. For example, handling the paper lot from one machine to another which can speed up the changeover of material.		

1i to 2i	**Implement AGVs on the shopfloor**	🟩 1	🟨 2
Smart Production	AGVs can support automated and continuous supply of material to the workstations and movement of semi-finished goods on the shopfloor. AVGs can be commended and maximize the efficiency of material flow.		

1i to 2i	**Using AI and machine learning algorithms to optimize production processes and reduce waste**	🟩 1	🟨 2
Smart Production	By identifying inefficiencies, automating tasks, and reducing waste, AI and machine learning algorithms can help businesses to reduce their environmental footprint and increase profitability.		
1i to 2i	**Develop single source of truth**	🟩 1	🟩 2
Smart Technologies	Create a single source of truth by connecting all IT systems and platforms like eCommerce, ERP, MES and IoT platform and aggregating data centrally to remove data silos and bring consistency and quality to the data		
1i to 2i	**Set up BI tool**	🟩 1	🟩 2
Smart Technologies	BI tool is necessary to analyse the large amount of gathered data from processes and production to create reports, dashboards and visualization that support the employees in decision-making and optimize performance		
1i to 2i	**Implement data governance framework**	🟩 1	🟩 2
Strategy & Organization	With the huge amounts of data being captured, data governance framework is necessary to define policies and standards in the organization to understand data quality and capture value from it.		
1i to 2i	**Set up continuous improvement teams**	🟩 1	🟩 2
Strategy & Organization	Set-up a a team to create a culture of continuous improvement and actively drive and handle projects. The cost can be reduced and enhance their innovation capabilites.		
1i to 2i	**Qualify employees to handle and analyse data**	🟩 1	🟩 2
Strategy & Organization	Train employees to use data for analysing it, understanding the correlations and derieving actionable insights, hiring data scientist who can work well with data. This can improve the correctiveness of use of data which can maximize the output of digitaization.		
1i to 2i	**Develop agile working culture**	🟩 1	🟩 2
Culture & Mindset	Develop a mindset where employees work in a agile style, ie, collaborating and learning, strongly promoted by leadership, teams work in a self-organizing way. By adopting an agile approach, the organization can respond quickly to changing market conditions and customer needs. This can help to reduce time to market and improve overall competitiveness.		

1i to 2i	**Enable data-driven decision making**	🟩 1	🟩 2
Culture & Mindset	Create a culture where data is considered as an asset and trust on results of data analysis and is used by everyone in the organization and not just data owners and data scientists for making decisions and optimizing performance		

Level 2i to 3i: Predictive analytics, human-system and system-system collaboration, and decentralized decision-making are required for the transformation to level 3i.

2i to 3i	**Business model evolution based on self-adjusting algorithms**	🟨 1	🟩 2
Data-driven business model	Machine learning algorithm for adjusting the business model according to market changes and the environment of business. By analyzing data on market trends, customer preferences, and environmental factors, the organization can make informed decisions about its business model. This can help to improve overall efficiency and reduce costs.		
2i to 3i	**Automated estimation of delivery dates**	🟨 1	🟨 2
Smart Products and Services	According to print complexity and providing customer information on effects of design changes, e.g., in case customer changes certain design element by 11th of next month then they can meet the deadline since raw material will be delivered in time of production start, but if design is changed on a later date, then delay by 1 week as schedule for next days is busy		
2i to 3i	**Demand forecasting**	🟨 1	🟨 2
Smart Processes	Use of AI methods to accurately forecast demand using historical customer data and market analysis. By accurately predicting demand, the organization can optimize its inventory levels, reducing the risk of overstocking or stockouts. This can help to reduce inventory holding costs and improve overall efficiency.		
2i to 3i	**Digital supply chain twin**	🟨 1	🟨 2
Smart Supply Chain	Further develop supply chain twin by using simulation and AI algorithms to test possible scenarios and predict how decisions will affect and prepare for any disruptions		
2i to 3i	**Digital twin of production**	🟨 1	🟨 2
Smart Production	Simulate scenarios with digital twin to identify risks as well as optimize costs and efficiency, test real-world scenarios to steer future decisions. To simulate various scenarios, the organization can identify potential risks and their impact on operations. This can help to reduce the likelihood and severity of disruptions and ensure continuity of operations.		

Level 3i to 4i: Based on the assessments and research, it is evident that currently the dimension of adaptability is beyond scope for the printing industry and no best practices are seen.