THE ROLE OF DIGITAL TRANSFORMATION AND SPECIFICATION DATA MANAGEMENT IN STREAMLINING SUPPLY CHAINS

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TITLE: The Role of Digital Transformation and Specification Data Management in Streamlining Supply Chains

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ABSTRACT

The Role of Digital Transformation and Specification Data Management in Streamlining Supply Chains

Daniel Bruce Klemm

The packaging and product supply chain is currently undergoing a digital transformation that changes the way organizations manage data. Cloud-based software is an emerging technological innovation entirely focused on harnessing the power of packaging/product specifications to create efficiencies. These applications coordinate the data that millions of SKUs worldwide are generating into a harmonized system that will not only organize the SKUs but also create valuable information that will allow stakeholders to make decisions based upon data-driven insights.

Specifications are the DNA-level information of packaging and products. Items such as the bill of materials, technical drawings, and inventory are stored together to create a traceable trail of information for stakeholders along the supply chain to refer to in the face of recalls, sustainability reports, and root cause analysis of procurement delays. Organizations have gone from storing this data on paper to creating a digital trail with manual processes and legacy systems on the computer. However, these systems cannot contend with the sheer amount of data companies now possess, wasting time and money trying to organize it all. In addition, packaging and product specification data lacks a common language that creates consistency and reduces errors; tracing an item to its source is a laborious endeavor; and resource investment is trying to solve the problem with existing manual processes and legacy systems when funding should go towards an innovative, cloud-based solution.

Such a system would be able to process data and create a standardized template for specifications. This organization would allow for fast querying and advanced analytics that turn into visualizations that illustrate the insights. This framework would create a single point of truth for specifications that would enhance how companies along the supply chain collaborate and share information and streamline packaging and product creation workflow. Software solutions for specification data management exist in varying levels of involvement and installation that allow stakeholders to find a model that fits their needs in an ever-changing supply chain management landscape.

Keywords: digital transformation, specification data management
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1. INTRODUCTION

A digital transformation refers to technological innovations in the form of software solutions that fundamentally change how businesses operate and create value for consumers (“What Is Digital Transformation?”). Often, this means switching paths completely when it comes to business practices and legacy systems that have been in place for decades and starting fresh with operations that have yet to flesh themselves out entirely. Technological innovations such as “cloud computing, Subscription-as-a-service (SaaS), augmented data management, augmented analytics, artificial intelligence (AI), APIs and mobile devices” are creating a multi-faceted environment for businesses to manage their data and fast-track decision-making processes (Blake). The software solutions market expanded to $3 billion in 2020 and, based on projections, will grow by at least 10% year over year throughout the next five years (Banker). Organizations are in the early stages of applying these innovations to packaging and product specifications; Gartner’s 2021 “Market Guide for Packaging and Product Specification Content Management” polled companies across five industries to determine how they manage their packaging specifications and found that only 23% of the participants across all industries use software from a “specialized software provider.” This poll puts the current market at the beginning of the early adopter phase of Everett’s innovation adoption curve (see Figure 1), further emphasizing the potential for the market’s growth. Therefore, companies will continue to rapidly incorporate more digital solutions to their specifications as a direct response to the increased demand for
businesses to manage corporate social responsibility, SKU growth and complexity, and consumer trends—all while attempting to increase speed-to-market and minimize costs (Blake).

Figure 1: Everett’s Innovation Adoption Curve (Rogers 247)

The expansion of SKUs has made managing various packaging and product specifications an administrative nightmare. There are roughly 200+ million packaging SKUs worldwide and 60 million in the United States (“Best Practices”). As this number continues to grow, the demand to manage all the packaging and product specifications also increases. In particular, the agricultural industry is suffering from an overall lack of a specification data management (SDM) system that allows information to move with a high level of traceability and transparency along the supply chain (Folinas et al. 631). Profit margins are already small in the agricultural business, and companies must now decrease time to market for products, report on sustainability and compliance to standards, and reduce costs across the board (Folinas et al. 631; “Specifications Are the
Littlest Form”). These objectives necessitate that packaging and product specification data be accurate, up-to-date, and accessible by anyone, anywhere.

Currently, many supply chains still operate based on paper, manual processes, and legacy systems. However, a transition towards the digital transformation of SDM systems is inevitable to respond and adapt to sudden changes in consumer behavior, health codes, and government mandates (“What Is Digital Transformation?”). This change is essential now more than ever at the onset of the 2020s amid the Covid-19 pandemic as supply chains face more and more disruptions, time to market becomes increasingly short, and conscious consumerism is prevalent (“What Is Digital Transformation?”). Therefore, it is of the utmost importance that supply chains make themselves more agile to avoid future events such as the Covid-19 pandemic that could significantly affect the day-to-day operations of a supply chain (Roese and Reichenbach). For example, working remotely in the product and manufacturing world is challenging without digitization. In addition, packaging, quality assurance, and operations employees have vital roles in the supply chain that currently necessitate their presence (“The ‘NEW’ Normal”). However, Covid-19 has made this nearly impossible to achieve without completely changing packaging and product workflows management. SDM networks can make these jobs possible in a suddenly more flexible way that encourages innovation.

Digitization has allowed for the dissemination of information through the cloud rather than manually. Before, an employer in one of the roles mentioned above in the supply chain would need to take time off or work from home, which
would seriously affect a packaging or product’s workflow. By transitioning packaging and product specification data into a digitized SDM, employees have greater flexibility to access data and manage projects ("The ‘NEW’ Normal"). With that in mind, the responsibility of IT departments has shifted from finding ways to generate cost savings within their company’s current data management systems to now transferring packaging and product specification data and workflows via a digital transformation to a more specialized cloud-based software solution to innovate and create competitive advantages ("What Is Digital Transformation?").
2. DEFINING SPECIFICATIONS

A specification is “a detailed instruction of work to be done and/or the materials to be used to complete the job” and could otherwise be known as a set of instructions, guidelines, parameters, requirements, or conditions (“Best Practices”). Packaging and product specifications are composed of everything that goes into creation-- from ideation, raw material extraction, processing and manufacturing, distribution, all the way to the consumers’ hands (“Specifications 101”). Whether it be a bag, box, or bottle, specifications have numerous unique characteristics; the same goes for an SKU’s primary, secondary, and tertiary packaging (Blake). For example, a carrot purchased in a grocery store has numerous specifications, including the components of the dirt it is grown in, the tractor used to farm the produce, the box and pallet used to ship the carrot, as well as the characteristics of the carrot itself. Any product that is “developed, grown, or manufactured” has specifications that make up its DNA, and each point along the supply chain adds to the specification in the creation of the product (see Table 1) (“Best Practices”).
Table 1: Vital attributes for a complete packaging or product specification (not including a bill of materials)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Inbound Logistics</th>
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<tbody>
<tr>
<td>Material</td>
<td>Outbound</td>
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<td></td>
<td>Transportation</td>
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<td>Performance</td>
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<td>Graphics</td>
<td>Quality Reports</td>
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<tr>
<td>Vendor Information</td>
<td>Inventory</td>
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</tbody>
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Source: “Best Practices”

Vital to a specification is the bill of materials (BOM) seen in Figure 2, or a detailed “list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and the quantities of each needed to manufacture an end product” (“Specifications 101”). Different types of BOMs break down a product differently based upon the process it represents.
### Bill of Materials

<table>
<thead>
<tr>
<th>Raw materials</th>
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<tbody>
<tr>
<td>Product components</td>
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<tr>
<td>Assemblies, sub-assemblies, or Processed Components</td>
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<tr>
<td>Purchased components</td>
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<tr>
<td>Primary packaging</td>
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<td>Secondary packaging</td>
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<td>Tertiary packaging</td>
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<tr>
<td>Labor</td>
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<tr>
<td>Unitizing information</td>
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<td>Shipping and loading</td>
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**Figure 2: Bill of Materials (“Best Practices”)**

For example, an engineering BOM, or EBOM, breaks down a product based upon the Computer-Aided Design (CAD) or Electric Design Automation (EDA) created during the design phase (A). Therefore, the EBOM would look different from a manufacturing BOM (MBOM), whose components would be the
pieces necessary to create a finished product, along with the quantity of each needed component (A). At the bottom of Figure 3 is a BOM with some of the ingredients necessary to produce the item.

Figure 3: Vanilla Ice Cream BOM (“Recipe and Packaging BOMs”)

The BOM and other specifications illustrate product expectations to stakeholders along the supply chain and give them a model for comparison. Specifications provide standards for function and aesthetics and minimize defects by conforming to a detailed uniform specification (“Specifications 101”). Notably, a packaging specification gives information on product sourcing, which is crucial as it is becoming more and more expected that companies are aware of and make it apparent to the consumer how their products are sustainably produced (Wright 7). In addition, consumers are growing in their desire to do
business with transparent companies in how they produce goods, how those goods are sustainable, and their general social responsibility standards (“Total Economic Impact” 3).

For example, ethical issues such as the source of labor for a product is a specification that allows consumers to ensure that their purchases are not the result of child labor. Additionally, the food industry requires significant detail in its product and packaging specifications to ensure consumer health. For example, consider a machine that cleans both non-genetically modified tomatoes and tomatoes with GMOs; it is necessary to ensure that the machine is clean when switching from GMO to non-GMO tomatoes; otherwise, the non-GMO tomatoes are contaminated (Folinas et al. 629). Therefore, there is a specification to denote the cleaning of the machine. Finally, if there is a recall on a food product, it is crucial to view the entire journey along the supply chain that the recalled product took to the consumer, and the product specification is the key to ensuring the recall of all applicable products and the speedy determination of fault through a root cause analysis. Ultimately, specifications are the DNA of supply chains, and specification data management allows industries to operate efficiently and safely.
3. THE CURRENT STATE OF SPECIFICATION DATA MANAGEMENT

3.1 HISTORY OF SPECIFICATION DATA MANAGEMENT

The management of specification data has, for the most part, transferred from manual recording on paper to the computer with the invention of radio frequency identification (RFID) technologies and various software systems, making tracking and data storage a lot more reasonable (Folinas et al. 624). Currently, Excel spreadsheets, homegrown systems, ERPs, PDFs, and shared drives comprise how most organizations manage their packaging and product specifications (“Specifications Are the Littlest Form”). However, as SKUs have increased and become more complex, IT leaders have employed the concept of “lift and shift,” where they add on to existing systems such as ERPs whose original purpose was not to manage specification data (“Specifications Are the Littlest Form”). Legacy systems possess a massive amount of data relating to specifications and the entire business and moving all of it would be a costly and challenging task. Additionally, many companies have specific software for their relationships within the individual business, the suppliers they work with, and the production of goods that houses different pieces of a complete specification for a package and product in respective software systems (Roese and Reichenbach).

3.2 COSTS OF ARCHAIC SPECIFICATION DATA MANAGEMENT SYSTEMS

Manual processes and legacy systems cannot create transparency to scale; frequently, data will flow from “the developer to procurement to the supplier,” and
it is not shareable across the entire supply chain at a moment’s notice for every single specification in question (Blake). Not only that but also manual and legacy systems rely upon user input which inevitably leaves more room for errors and miscommunications. Delayed artwork, compromising quality tracking through poor data management practices, and suppliers making products incorrectly or with the wrong materials are all examples of such issues (Blake). Blake’s 2019 survey of IT professionals found that 97% agreed that delays in strategic decision-making, missed revenue and cost savings, and slow product rollouts all occurred within their organizations due to poor data management. Blake’s study concluded that, among the same group of IT professionals, almost half of them were using applications such as Excel and Word or leaving it to their suppliers to manage their specifications.

There has yet to be a standardized way to digitally manage all these packaging and product specifications, and companies have instead operated through Excel and PDF documents shared over email -- an inefficient and error-ridden way to manage data ("Best Practices"). In addition, ERP and PLM systems do not focus on packaging and product specifications, and document control systems are not easy to search or capable of data analysis ("Best Practices"). As a result, many companies hold on to these legacy systems holding monolithic amounts of data that will stand in the way of companies changing their fundamental business operations. Digitization is a long-term investment that will upend routine procedures, but companies that hold on to their legacy systems will soon lack agility in their ability to make decisions.
Packaging and product data lacks a common language that makes accumulating all the pertinent data difficult and sharing the data with partners and vendors even harder. The existing ERPs and PLMs do not solve companies’ lack of possession of the specification data (Wright 2). As a result, specifications are not the same across the board for all stakeholders and scouring through lines and lines of data on Excel sheets takes time away from the actual tasks at hand or value-added activities. This inconsistency of specification sources runs the risk of confusion amongst teams and suppliers that result in slower rollouts to market, while also limiting the possibility of innovation by not giving all pertinent stakeholders in the value chain the opportunity to have all the correct specification information and give their unique insights (“Specifications 101”). Furthermore, the conglomeration of incompatible and inappropriate management systems for packaging and product specifications separates specification data and does not allow for a free-flowing environment through which stakeholders can effectively access and analyze specifications.

Consumers desire a combination of personalization, quality, and urgency in the products they purchase (“The Intersection of Blockchain”). Organizations are also growing more conscious of the products they buy, and supply chain transparency must be prevalent so that companies may display whom they source from and where they produce goods (“Best Practices”). In addition, globalization has allowed consumers to purchase from places worldwide and for companies to do so for raw materials. This trend creates an incredibly complex digital trail along the supply chain from a product’s inception to the consumer,
and it necessitates a high level of traceability and transparency across the supply chain for companies to align themselves with conscious consumer values ("Specifications 101"). Such a digital trail would be necessary for the hypothetical situation where a packaging company makes several companies' boxes. If the packaging company makes alterations to the box's specifications, all the companies need to be notified of the changes to determine whether the box still fulfills their needs. Email is a popular way to send notifications, which is another manual process likely to lead to delays and errors ("Specifications 101").

There is a great deal of opportunity for improvement in the management of specifications along the supply chain as the data in question has historically seen little investment in its storage and analysis (Blake). Currently, innovative technologies are being applied only to processes within legacy systems already in place (Roese and Reichenbach). Instead of incurring the costs of these inefficiencies, companies could employ a digital SDM system to streamline their process. In addition, a digitized SDM system is a foundation for supply chain data that harmonizes and ensures the accuracy and efficiency of PLM, ERP, and VIZ systems that companies employ (Wright 6). Just like all of these have specialized applications and focus on managing a particular set of data, so too does SDM software serve a unique purpose that is crucial to the flow of information along the supply chain.

Transitioning specification data to a cloud-based software service allows organizations to maintain their legacy systems by extracting only the necessary data about packaging and product specification data, making it a more palatable
transition ("Specifications Are the Littlest Form"). The addition of a digital SDM will create a digital trail of specification information and automated workflow that will provide stakeholders with the necessary information to fulfill the needs of a constantly changing consumer. As more companies begin to transition to this data digitization, the deployment of blockchain will further embed a community of traceability and transparency across industries that rely upon specifications ("The Intersection of Blockchain").
4. A DIGITIZED SPECIFICATION DATA MANAGEMENT SYSTEM

4.1 FRAMEWORK

At its base, an SDM system allows packaging organization and capabilities for specification data in such a way to grow the packaging and product specification community in a scalable manner. Organizations that deal in packaging and product specifications operate with an SDM through legacy systems and manual processes that only allow for data searches (Zhang et al. 1). As the amount of data available increases, the sorting and sharing of information becomes even more challenging. By introducing a digitized SDM network architecture that focuses on accumulating data across the entire supply chain with all stakeholders, the application removes the data from the individual software applications within a legacy system. It allows for data to move between producers, suppliers, and any other stakeholders in the supply chain (Roese and Reichenbach). The goal is a data platform that allows users to pivot from data searches to analysis to a greater understanding of the data in question (Zhang et al. 2). Such a cloud-based software would have a framework (Figure 4) made up of the following categories: identification and classification, transformation and modeling, processing, and presentation of traceability data (Folinas et al. 625). This digitized SDM must be easy for users to operate, give timely feedback to ensure more effective communication along the supply chain, and create a visual story by utilizing data to create queries that become models, charts, and graphs (Zhang et al. 3).
4.2 A SINGLE SOURCE OF TRUTH

A digitized SDM system creates the common language necessary to ensure that specifications shared across critical stakeholders in the supply chain are uniform. This synchronization houses specifications on a digitized SDM system that is the single source of truth ("Specifications 101"). Because the specifications are the same across the supply chain, there are fewer purchasing and supplier errors; suppliers know what to deliver, and the product arrives as specified with less chance of delay ("Best Practices"). Moreover, the entire supply chain's ability to operate with the same specification information mitigates the chance of miscommunications and results in cost savings from reduced errors and product recalls (Finnerty 3). In fact, product and packaging precision
allows companies to go from having acceptance quality limits (AQL's) in their manufacturing to demanding zero defects of themselves and their manufacturers ("Specifications 101"). This improvement contributes to further down the supply chain where customers happily receive authentic products on time, maintaining or even improving brand reputation ("Best Practices").

Packaging and product development also benefits from a single source of truth concerning specifications. Development occurs across multiple departments, meaning different employees with engineering, marketing, and quality assurance backgrounds will need access to specifications (Blake). A cloud-based SDM system ensures that all stakeholders look at the same specifications, including critical documents such as drawings and certifications, creating less cross-department confusion. As a result, the development cycle time for packaging designs decreases, and the time-to-market decreases ("Best Practices").

Utilizing a specification data management system lets employees waste less time dealing with inaccuracies and out-of-date specifications and focus more on value-added activities, resulting in streamlined workflows. In addition, having one system to learn with a standardized template for all specifications and suppliers ensures that both employees within the business and employees onboarding from across the supply chain do so faster and more efficiently ("Best Practices"). Forrester’s "Economic Impact of Specright" study, based on the specification data management company, showed that having specifications in one simple place freed up employees along the supply chain so that they could
focus on value-added activities, creating three extra hours per week for employees to focus on such activities and increased employee satisfaction with their job (Finnerty 4).

4.3 COLLABORATION

Digitization allows for greater collaboration within a business amongst different specialties. A cloud-based SDM gives the formation of new products and packages a greater perspective by allowing more stakeholders to see a product and provide their input as to its impacts upon the rest of the product offerings and the business as a whole (Roese and Reichenbach).

Digitized SDM systems give companies greater agility. For example, suppose a buyer wants information about sellers' products and is on the same network. In that case, the buyers are more quickly able to assess whether they want to do business with the seller by requesting product information, saving time for both parties, and giving buyers the flexibility to get bids from more suppliers in order to ensure that suppliers can procure a product with the exact specifications desired (Banker). Conversely, smaller vendors can make proposals to buyers more often by engaging in RFPs possessing the desired specification (Blake). A collaborative SDM network removes the veil of secrecy regarding specifications, giving more suppliers a chance to find innovative ways to manufacture packaging and products.
Including other stakeholders along the supply chain allows for another lens of analysis for packaging and product specification and a greater level of transparency in a package/product’s life cycle (Roese and Reichenbach). The ability for specification data to be shared along the supply chain means that there is a more significant opportunity to insert more checks and balances to identify errors that will result in faster product rollouts, greater tracking of product quality along the supply chain, and a decrease in the cost of goods (Blake). In addition, companies will have in-depth access to the characteristics of their raw materials, and in doing so, they will be able to ensure that their products are compliant with whatever standards are imposed and have less chance of product recalls (Wright 2).

A great example of the power of collaboration along the supply chain is the transformation in the relationship between the retail superstore, Walmart, and the consumer goods manufacturer, Procter & Gamble (P&G). According to a case study written by industry experts Grean and Shaw in 2002, the two companies sold $375 million of product in 1988, equivalent to $870 million today, and the companies’ relationship was struggling because they were competitors and collaborators at the same time. As a result, they shared minimal business data and instead focused solely on transactions from P&G to Walmart and then to the consumer. Their lack of collaboration (Figure 5a) combined with different standards for tracking sales led to discrepancies in data that further divided the two companies’ relationship (Grean and Shaw 4).
Figure 5a: Walmart and P&G’s relationship before creating a strategic partnership (Grean and Shaw 6)

However, this soon changed when P&G and Walmart decided to form a strategic relationship and create value for both companies despite being competitors. They created a standardized system for sales tracking and a system whereby data was shared freely on all business functions rather than just sales (Grean and Shaw 8). Figure 5b illustrates this inversion in their relationship. The formation of an "extranet" created a private network between P&G and Walmart to share data about all business functions (Grean and Shaw 18). This collaboration between the two companies ensured a single source of truth through a standardized template for recording sales and analysis of consumer
habits. As a result, Walmart carried less of P&G’s inventory that focused on what consumers were buying (based on data analytics) and resulted in the businesses doing $4 billion of sales in 2002, or $6 billion today (Grean and Shaw 6). In the context of a digitized SDM system, competitors and collaborators alike would gain from employing a standardized way of disseminating specification data to reduce their inventories, cut costs, and better understand consumer habits.

Figure 5b: Walmart and P&G’s relationship after creating a strategic partnership

(Grean and Shaw 6)
4.4 ACCESSIBILITY

SDM allows companies to oversee their specifications rather than having a vendor along the supply chain manage them. This ownership creates a level of independence that allows companies to act with more agility in seeking out the most competitive bids for a particular specification on a more frequent basis. Organizations can create new products and build their bill of materials through an SDM system using materials from approved suppliers (Finnerty 9). As a result, organizations can manufacture products at competitive prices without having to worry about regulatory concerns. Owning specifications is also more cost-effective than having suppliers hold specifications (Blake). Organizations are also much more responsive because of their ability to access their specifications more quickly; new opportunities arise in the form of business and marketing opportunities (Finnerty 7). As consumer trends more and more towards product customization, agility in changing product and packaging specifications becomes crucial, and owning specifications makes the information searchable and easy to find (Finnerty 13).

Moving specification data from hard copies to the cloud enables greater accessibility from more locations and more devices, ensuring quicker decision-making improving the time-to-market of a product in the future (Wright 9). A significant source of time delays in a global business can come from the slow and inefficient process required to approve a packaging specification in its development (ESKO 3). Consolidation of living documents ensures that all pertinent stakeholders view real-time workflow updates. Any delays in this
workflow could have severe repercussions on the success of a product. Therefore, organizations must use an SDM system that allows all pertinent stakeholders to view, verify, and approve any changes in specifications through the web or a mobile device anywhere in the world.

**4.5 AUTOMATING WORKFLOWS**

Digitized SDM systems are the missing link between specifications and SKUs ("Specifications 101"). They give stakeholders the ability to follow a product as it is revised and receive approvals with instantaneous gratification, giving organizations a greater chance of reducing errors in creating a product and product packaging by ensuring that every different stakeholder has one single reference point (ESKO 4). By mapping out and automating approval processes, less time is spent on administrative duties, and the bidding process is carried out more quickly ("Best Practices"). Additionally, the development of checkpoints along the approval process creates a counterbalance that stifles neither creativity nor efficiency, and automated workflows also ensure the artwork is correct ("Best Practices"). For example, requests for specification information, like a packaging drawing, can be made without involvement from the supply chain management team, allowing other sectors of an organization to have instantaneous access to up-to-date packaging specifications (Finnerty 7). Project timelines can also be made more accurately by automating approval processes that otherwise cause unforeseen time delays and reduce development cycle time for future designs ("Best Practices"). As a result, there is a reduction in
shipment delays and the administrative costs that go along with them ("Best Practices"). Finally, by ensuring that a product and its packaging roll out in a timely and efficient manner, the organization's brand benefits by looking trustworthy and reputable (ESKO 5).

Accessibility to specifications and the automation of their approval processes creates a digital trail through which higher levels of traceability are made possible. Many recalls and products have occurred due to simple mistakes such as ingredients lists not being updated (Finnerty 5). However, the SDM system will ensure that any change in ingredients or the like will result in quick updates to specifications. Moreover, if there is a recall, a digital trail allows for faster root cause analysis by illustrating a clear history of current and obsolete specs. SDM systems also automatically notify businesses when it is time to renew regulatory documents; organizations can be more agile in responding to regulatory changes and decrease their risk of not adhering to those changes (Finnerty 8). Government standards require that the food and feed industry trace products to both retailers and any food or feed source. (Folinas et al. 622). This information is not possible without high levels of traceability and transparency. A practical and accessible SDM system will identify stakeholders throughout the supply chain from the farmers, fishers, and cattle breeders to the packaging to the consumer, promoting transparency and retaining brand equity in the face of product recalls (Folinas et al. 622).
4.6 ORGANIZING SPECIFICATION DATA

Digitized SDM systems will automatically clean specification data and organize it with an analytical categorization system, removing errors and duplicates (“Best Practices”). Key specification attributes will also be required to make database querying easier, save time, and increase the efficiency of operations along the supply chain (Wright 7). As a result, stakeholders will no longer struggle with incomplete or even missing data, and they will be able to focus more on value-added activities. Suppliers will also be subject to an automated periodic specification data audit for accuracy, further decreasing administrative costs (“Best Practices”).

SDM applications will improve speed to market, cost optimization, and collaboration through features built to give otherwise disorganized and unused data a purpose and change the way companies sell their products (Blake). Disconnected data will transform into a transparent and accurate web of specifications that all necessary associates can access, allowing companies to understand consumer habits better and cater to their changing desires. This decreases abundance in purchasing consumption and increases customer loyalty to their products (Roese and Reichenbach). Companies will also have greater visibility of the items they are purchasing and create more efficiencies in doing so, whether through grouping more purchases together for discounts or eliminating duplicate items (Finnerty 4). In addition, harnessing this newfound data collection will help focus on the productive SKUs, more easily recognize
instances where packaging needs can be reduced while maintaining a high quality, and create optimal palletization setups (“Best Practices”).

4.7 SDM SOFTWARE SOLUTIONS

Digitized SDMs go by many different names and acronyms. Whether it be a supply chain collaboration network (SCCN), a multi-enterprise supply chain business network (MESCBN), or a packaging and product specification content management system (PPSCM), these digital packages manage product and packaging data for its entire lifecycle, from the gathering of initial resources through to the creation of a final product and the bill of materials to go along with it (Banker and Blake). SDM systems ensure that relevant and accurate data aid in specification development, RFPs, quality assurance, and meeting sustainability goals. In addition, SDM software creates an elevated level of insight using data visualization tools such as models and dashboards, creating new ways to manipulate previously disorganized data into metrics or even crucial performance indicators. SDM applications also illustrate a more transparent picture of an organization's supply chain, allowing users to manage the development of a package and product specification through the different geographical locations, SKUs, and organizations involved (Blake). There are currently three categories of applications for the management of specification-related data in the market:

"Specification content management enablers" are individual applications with unique attributes that focus on specific scenarios organizations may deal
with in the management of their packaging and product specifications (Blake).

Some examples of the different functionalities of specification content management enabler applications include:

- **Document control** - DocXellent’s ENSUR application creates a cloud-based environment through which specification documents like BOMs and diagrams can be transferred to from legacy systems to create a more streamlined workflow, as illustrated by Figure 6 (Blake).

  ![Figure 6: DocXellent’s ENSUR application ("DocXcellent")](image)

- **Artwork and specification synchronization** - In the ManageArtworks application (Figure 7), all graphics that pertain to a packaging or product will be attached to their corresponding specifications to maintain harmonization of the full scope of a product through its lifecycle (Blake).
• Linking data- Data spread across various incompatible applications is brought together to create a full specification, ensuring that the perception of a product or package is the same for all stakeholders (Blake).

Mareana’s qSuite application compiles different types of data (see Table 2), some of which are listed in, from legacy systems and pairs it with drawings and PDFs directly relating to a specification (Blake).
Table 2: Mareana’s qSuite application transforms a variety of data types into organized specification templates

Some examples of the unstructured data we mine include:

- Emails
- Microsoft Word Documents
- Videos
- Photos
- Audio files
- Presentations
- Web pages
- Chat logs
- Medical records
- JPEG or other image files
- Mobile app data
- Mobile location data
- Engineering drawings

- Blueprints
- Text messages
- IoT app data
- Product catalogs
- Journal articles
- Research support papers
- Reviews
- Observation studies
- PDFs
- Capital Equipment device log files
- Maps and topographical information
- Long Text fields in standard enterprise systems (SAP, Oracle, etc.)

Source: “Unstructured Data”

- Audit vendor compliance with regulations- With the QADEX SDM application (Figure 8), organizations will have immediate viewing access to determine whether vendor specifications align with corresponding regulations and standards.
Figure 8: QADEX regulation and standards dashboard (“Food Safety Software Solutions”)

Product Lifecycle Management (PLM) applications operate within a pre-existing software service and manage a range of information through the lifespan of the product and its packaging (Blake). This includes managing the conception and progression of packaging and product ideas, storing and updating specifications, and the automated auditing of specifications for regulatory compliance. For PLM applications to achieve a DNA level of granularity for specification management, further customization of the application may be necessary (Blake).
Figure 9: Devex offers workflows unique to different products

(“Out-of-the-Box PLM Templates”)

For example, Devex offers various PLM applications that differ based on the product they manage, as depicted by the unique workflow in Figure 9 unique to food products. Centric Software provides a different take on customizable applications by offering various modules that serve different functions (Figure 10).
Finally, “purpose-built” SDM Applications are focused solely on managing product and packaging specifications, a key difference between other applications that offer packaging and product specification management as an add-on (Blake). This focus has resulted in numerous packaging and product specification-focused applications within the software options. GlobalPKG, for example, has SDM software that allows for the design of packages and products based on specifications already housed in the cloud, as seen in Figure 11.
Figure 11: GlobalPKG allows users to design within their SDM system ("Smart Packaging Management")

According to Gartner’s Market Guide for Packaging and Product Specification Content Management, “tracking sustainability metrics for products and packaging, documenting production line equipment and spare parts, quality assurance, supplier quality audits and project management workflows” are a few other advanced functionalities that these dedicated SDM applications offer.

Figure 12 and 13 show Specright’s ability to manage workflows automatically and
create dashboards for sustainability reporting using advanced specification metrics, respectively.

Figure 12: Specright automates workflows and notifies stakeholders

(“Specification Management”)
Figure 13: Specright allows users to create dashboards using advanced data analytics ("Specification Management")

The main costs having to do with SDM software are the licensing for both employees of organizations as well as key members in the supply chain to use the software, along with the costs of training new users to use the system—equivalent to about 5 hours per user (Finnerty 20). However, this amount of money is negligible when considering the amount of savings incurred from streamlining project workflows and reducing the risk of product recalls (Finnerty 5).
5. CONCLUSION

A wide variety of software solutions exists to cater to the different needs of different organizations. Regardless of which application/set of applications an organization picks, a digitized SDM will be invaluable going forward. Specification data must be utilized to create efficiencies in sourcing, processing, production, and transportation workflows and better understand consumer trends. Greater precision and shorter delays in production will make customers happier and improve sustainability by decreasing SKUs. Using a cloud-based solution for SDM will create a common language between stakeholders along the supply chain that reduces errors by inverting the idea of data being private to share along the supply chain, thereby creating a strategic advantage for all stakeholders—competitors and collaborators alike.

Digital transformation is changing the way companies think and act. As a result, employees have more flexibility in their work, and businesses are more agile than ever before. The evolution of specification data management is emblematic of this transformation, and the space will continue to progress as more companies incorporate cloud-based solutions.
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