Identification and Characterisation of Archetypes for Decentralized Manufacturing Systems

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Abstract. Decentralized manufacturing systems (DMS) are increasingly discussed as a practical response to high product variety, shorter delivery-time requirements, production sovereignty, and sustainability-driven pressure to produce closer to demand. However, many studies remain conceptually strong while offering limited procedural guidance for translating DMS descriptors into actionable deployment logic. This paper identifies DMS deployment archetypes from cross-sector case evidence using a descriptor-to-archetype workflow. Thirty product cases spanning ten manufacturing sectors were grouped into five deployment archetypes: Factory in a Warehouse (FiW), Factory in a Container (FiC), Factory in a Store (FiS), Factory in a Kiosk (FiK), and Factory in a Hospital (FiH). Product-specific process labels were harmonized using DIN 8580 and encoded into aligned matrices for process relevance, resource usage, automation, customization, and product morphology. The results show that the deployment archetypes are distinguishable on both the process and product sides: warehouse-based DMS align with broader, more resource-intensive, and more standardized chains, while compact and specialized formats cluster around narrower process breadth and different product morphology profiles. The study contributes a descriptor architecture that identifies and characterises DMS archetypes from industry evidence, translating them into profiles usable for early-stage planning.

Keywords: decentralized manufacturing systems, archetypes, rough planning.

1 Introduction

Manufacturing has traditionally been organized around centralized production: large facilities, long runs, and geographically distributed delivery from a few hubs. That paradigm remains effective and valid for stable demand and high-volume repetition. Centralized manufacturing systems (CMS) remain especially advantageous where capital intensive equipment, high-throughput operations and economies of scale are critical to performance. This is evident in CMS production settings such as automotive, steel, and cement clinker production where high volumes and concentrated resources support efficiency and cost competitiveness [1].

Today, however, the context is increasingly shaped by higher product variety, shorter delivery windows, the need for production sovereignty and customization

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pressure [2] [3] [4]. Decentralized manufacturing systems (DMS) are one response to this shift, distributing production capability closer to demand while retaining the value-creation logic of manufacturing systems. DMS can also support circular and resilience goals by enabling local repair, shorter recovery loops, and remanufacturing [5]. Prior work discusses DMS benefits such as responsiveness, proximity-driven logistics reductions, and modular scaling, but DMS archetype definition consensus remains limited [6] [7]. This raises the question: How can DMS archetypes (i.e. recurring types) be identified and characterized from industry evidence to support early-stage rough planning? Without such a workflow, comparing, operationalizing, and using DMS as a practical reference for industry becomes difficult.

While DMS is not a new concept, this study contributes a descriptor architecture that identifies and characterises DMS archetypes from industry evidence, translating them into profiles usable for early-stage rough planning. This is achieved through a descriptor-to-archetype workflow applied to a cross-sector dataset of 30 product cases, harmonizing process labels into descriptor matrices and deriving archetype-level insights through product and process heatmaps.

2 Background and Research Demand

A manufacturing system can be framed as an integrated arrangement of equipment, human resources, and processes that adds value to products [8]. Within that baseline, DMS redistributes production capability across locations nearer to demand contexts, often emphasizing modularity, deploy ability, resilience, and responsive operation [9]. Table 1 summarizes the DMS definitions and the descriptor terms used in this study.

Table 1. DMS definitions and descriptor terms from relevant papers.

Year	DMS definition	Descriptor terms captured
2012	"A DMS is a scalable, modular, and geographically distributed unit, located in proximity to the customer" [6]	scalable, modular, distributed, customer proximity
2015	"DMS is an ideal manufacturing system where production takes place closer to the customer and is produced as locally as possible." [7]	local production, customer proximity, local manufacturing
2015	"Through decentralized and on-site located mini factories, local tastes and requirements can be considered in product definition." [9]	on-site mini-factories, local requirements, local production
2016	"DMS refers to a glocal production that occurs close to the customer, reducing transport emissions." [5]	glocal, market proximity, reduced transport
2018	"DMS divides manufacturing across geographic regions, promising local, responsive manufacturing." [10]	distributed capacity, local manufacturing, responsive
2025	"In healthcare, DMS is local to the patient at locations such as hospitals, pharmacies, or mobile units." [11]	local-to-patient, point-of-care, multiple sites

The definitions reviewed here span 2012 to 2025, intentionally tracing the evolution of how DMS has been described over time rather than restricting coverage to recent literature alone.

Across these references, four descriptor families recur: localized production, proximity to demand, customization, and scalability through multiple units. Table 2 records the presence/absence tally of these descriptors across the sampled definition set and provides the descriptor background used later for variable selection.

Table 2. Descriptor tally across sampled DMS definitions.

Paper	Localized production / site	Customer proximity	Customization	Scalability / multiple units
[5]	X	X	X	X
[6]	X	X	X	X
[7]	X	X		
[9]	X	X	X	
[10]	X	X		X
[11]	X	X	X	

The literature also links DMS to sustainability-oriented planning through production sovereignty, accessibility, and manufacturing resilience through distributed capacity [7] [9] with more recent deployments extending into smart manufacturing and Industry 5.0 contexts such as point-of-care production and automated systems [10] [11]. Yet, many studies remain descriptor-rich but method-light: descriptors are described, yet fewer papers provide a workflow that aggregates evidence and distinguishes deployment archetypes in a repeatable way. Accordingly, this study contributes a structured basis for understanding which descriptor combinations recur across cases, which building blocks distinguish one deployment logic from another, and how such patterns can inform early planning. In this sense, the study can support industry and practice by providing a common reference for screening, comparing, and shaping DMS concepts.

3 Methodology

3.1 Research Framework

The method follows a top-down enterprise architecture (EA) logic and adapts Bernard's layered EA framework [12] into three analytical tiers: business domain → information domain → data domain. EA is a hierarchical framework for organizing an enterprise from its business purpose down to the information and data used to describe it [12]. In this study, EA provides a structured basis for identifying and characterizing DMS cases by tracing each case from the business context to data-level descriptor representation.

In the business domain, the question is what business cases exist for DMS. Thirty DMS cases were sampled across ten manufacturing sectors as defined by NAICS [13]

and grouped into five deployment archetypes. These five archetypes are defined by the spatial deployment context in which production capability is embedded, that is, the type of host environment in which the DMS operates: Figure 1 summarizes these contexts visually as warehouse, container, store, kiosk, and hospital.



	Factory-in-a-Warehouse (FiW)	Factory-in-a-Container (FiC)	Factory-in-a-Store (FiS)	Factory-in-a-Kiosk (FiK)	Factory-in-a-Hospital (FiH)
Location	industrial warehouse environment	containerized and relocatable unit	retail or customer-facing store environment	small footprint kiosk-like service point	healthcare setting close to the point of care
Mobility	low	high	medium	medium/high	medium/high
Scale/size	large	medium	small/medium	small	small/medium
Customer involvement	low	medium	high	high	medium/high
Demand proximity	medium	high	high	high	high

Fig. 1. Overview of the five DMS archetypes [14] [15] [16] [17] [18].

In the information domain, the cases are analysed to identify the products being produced and the processes enabling production, forming a primary product–process map for the sampled DMS setups. The analysis is scoped as a gate-to-gate study, focusing on product and process descriptors within the deployment setting. Because companies often describe similar processes using different terminology, DIN 8580 is used to harmonize process labels into 43 standardized processes (Table 3) [19]. Since most companies do not publish full value streams, the mapping is based on publicly available sources and expert interpretation.

Table 3. DIN 8580 manufacturing process families used to harmonize process labels.

DIN 8580 Family	Processes
Shaping	Casting, Compacting, Deposition, Molding, Composite
Forming	Sheet Metal Forming, High Energy Rate Forming, Tube Forming, Extrusion & Drawing, Forging, Rolling, Bending
Separating	Deburring, Abrasive Machining, Blanking, Shearing, Piercing, Cutting Chips, Chemical Separating, Thermal Separating
Surface Treatment	Surface Modification, Dip Flow Coating, Printing, Thermal Coating, Chemical Coating, Spray Coating
Change Material	Through Hardening, Sintering & Burning, Annealing, Cold Working, Photochemical, Radiation, Magnetization, Surface Hardening, Thermomechanical Treatment
Joining	Assembly, Fastening, Adhesive Bonding, Welding, Soldering, Fitting, Brazing, Filling & Dispensing

In the data domain, the harmonized product–process map is encoded into aligned matrices (43 processes × 30 products). The base layer is a binary relevance matrix

indicating whether a process is relevant for a given product. Three additional coded matrices capture customization, level of automation, and resource usage. Together, these four matrices form the dataset used for the DMS archetype analysis, with variable definitions and analytical use formalized in Section 3.2.

3.2 Variable Descriptions

Building on the four coded matrices defined in Section 3.1, the analytical variables used in the next sections are organized into two sets (A and B) as described below.

Variable set A (process-side analytics): This set starts from a binary product–process map covering 43 processes and 30 products. From this base map, three process-side descriptor matrices are coded only where a process–product link exists. Resource usage captures the cumulation of the process in terms of energy, waste, material, safety [20], consumables, cycle time, tooling, labour [21] and precision [22], and is coded as 1 = low and 2 = high, where a process is assigned high when the majority of these characteristics indicate elevated burden, and low otherwise. Automation reflects how the process is primarily executed, and customization reflects the process variability. These are coded on a 1–2 scale: human (1) or automated (2), and custom (1) or standard (2) respectively. Product-level dominance ratios derived from these binary states are summarized using t-based 95% confidence intervals (CI), appropriate for the limited sample size and unknown population variance. A dominance ratio above 0.5 indicates that the majority of relevant process links lean toward the upper coded state (2), while a value below 0.5 indicates a lean toward the lower coded state (1).

To position each archetype along these binary descriptor scales without allowing products with longer process chains to disproportionately shape the result, descriptor scores are aggregated using a process-length-weighted average, so the final values indicate whether the value lies closer to the lower or upper coded state. Therefore, the weighted average indicates the relative descriptor tendency of an archetype, not its total cumulative footprint. These values are assigned through case-based interpretation of the available process descriptions, process evidence, and expert interpretation across the sampled cases. These three descriptors were selected because they capture core manufacturing system characteristics that recur across both the DMS literature and manufacturing systems theory [8].

Variable set B (product-side analytics): This set examines product-side DMS structure using a product morphology interpretation lens. Products are characterized using six qualitative morphology lenses (geometry, material, safety, lifetime, personalization, end-of-life) adapted from product-planning perspectives [23].

For readability, only the condensed summaries of variable sets A and B are reported, with one expanded view retained for set B to illustrate the resolution of the analysis.

4 Case Basis and Data Collection

This section describes the empirical basis used to build the descriptor architecture. Thirty DMS product cases were sampled across ten manufacturing sectors, making the product case the unit of analysis. The ten sectors were derived from the NAICS manufacturing scope by consolidating its 21 subsectors [13] into 10 broad categories: textile, pharmaceutical, energy, food and beverage, consumer goods, transport, health, wood, metal machinery, and electronics. Three product cases were selected per sector to ensure cross-sector balance. Cases were included when sufficient publicly available evidence existed to identify the product, deployment context, and main production processes. After identification, it was derived inductively that these 30 product cases could be grouped into five deployment archetypes based on their spatial host environment, as summarised in Table 4.

Table 4. Case basis: sampled products per deployment archetype (n=30).

Archetype	Products in sample (n=30)
Factory in a Warehouse (FiW)	Custom sportwear, cleaning product, EV charger, bus, flat package wood, and car.
Factory in a Container (FiC)	Healthcare kit, CNC wood cut, cold pack, cryogen, plastic artifact, oil, drone, hybrid metal part, machined part, and phone.
Factory in a Store (FiS)	Glasses, custom wood cut, juice, surfboard, shoe, and knitted sweater.
Factory in a Kiosk (FiK)	Ice cube, pizza, PCB, microchip, and 3D metal part.
Factory in a Hospital (FiH)	Implant, polypill, and dental insert.

Data were consolidated from publicly available sources and expert interpretation for the above listed 30 products. The resulting dataset encodes a process–product summary table as shown in Table 5 below.

Table 5. DMS Archetype and Process Group Summary Table.

DIN 8580 process family	FiW	FiC	FiS	FiK	FiH
Joining	79.2%	61.3%	41.7%	42.5%	37.5%
Surface Treatment	69.4%	53.3%	36.1%	23.3%	61.1%
Shaping	56.7%	42.0%	40.0%	24.0%	60.0%
Separating	60.4%	31.2%	29.2%	15.0%	29.2%
Change Material	48.1%	34.4%	16.7%	15.6%	55.6%
Forming	57.1%	25.7%	9.5%	5.7%	9.5%
Weighted Average	0.62	0.41	0.28	0.21	0.41

Table 5 shows that FiW is the most recurrent archetype, indicating broader process chains. FiK and FiS, by contrast, show lower recurrence, suggesting narrower process

breadth (i.e. number of process steps in the chain). At process level, Table 3 supports Table 5, showing that FiW and FiC exhibit the widest chains, including assembly, welding, brazing, and molding, whereas FiS and FiK are narrower and rely more on assembly, adhesive bonding, deposition, and selected finishing operations. FiH appears more specialized in photochemical, radiation, and other treatment-related processes, consistent with the profile in Table 5. Overall, product–process relevance follows the order FiW > FiC = FiH > FiS > FiK, suggesting that deployment context influences process breadth.

Process breadth alone, however, does not fully explain DMS. Section 5 therefore uses Table 5 as the basis to investigate resource usage, automation, customization, and product morphology, extending the analysis beyond process breadth to the broader characteristics shaping DMS archetypes.

5 Results and Discussion

5.1 Clustering of DMS Processes

This subsection interprets process-side characteristics using three descriptors: resource usage, automation, and customization, where the summary tables condense average scores across the six DIN 8580 process families. As in the rest of the paper, the results are treated as sample-based tendencies rather than as universal properties of all DMS.

Resource Usage. Table 6 shows that FiW is the most resource-intensive archetype in the sample, with the highest overall average across process families. Its strongest signal appears in shaping, particularly in primary transformation processes such as molding, deposition, and casting found in products like cars and buses (Table 4). This concentration of resource-heavy processes places FiW closest to CMS logic, as it accommodates broader process chains and therefore requires more space, equipment, and utility support. By contrast, FiS records the lowest overall resource score, consistent with customer-facing environments where industrial complexity must remain selective to limit safety, noise, space, and customer-experience constraints.

Table 6. Average Resource Usage Summary Table (High = 2.00, Low =1.00).

DIN 8580 process family	FiW	FiC	FiS	FiK	FiH
Forming	1.75	1.39	1.75	1.00	1.00
Shaping	1.82	1.24	1.17	1.33	1.56
Change Material	1.58	1.35	1.00	1.50	1.47
Separating	1.45	1.36	1.36	1.50	1.43
Surface Treatment	1.80	1.16	1.33	1.29	1.18
Joining	1.55	1.24	1.00	1.35	1.44
Weighted Average	1.64	1.28	1.20	1.36	1.40

FiC occupies a middle position, suggesting that containerized systems prioritize balanced multi-process capability rather than minimalism. FiH records the second-highest average, showing that technically demanding processes can also be decentralized in medical contexts. FiK remains relatively resource-light, indicating that kiosk-based deployments depend on compact process chains rather than broader factory infrastructure. At product level, the mean high-resource share is 0.3431 (95% CI: [0.2375, 0.4488]), statistically supporting the low-resource characterization of the overall sample. Overall, the ranking FiW > FiH > FiK > FiC > FiS shows that deployment setting strongly shapes resource usage.

Level of Automation. The automation results in Table 7 are more distributed than resource usage. Unlike resource intensity, automation is not concentrated in FiW alone. Instead, FiK records the highest overall automation average, indicating that FiK compensates for limited space by making the included processes controllable and repeatable. If only a few operations are included, those operations must work reliably with minimal intervention.

Table 7. Level of Automation Summary Table (Human=1.00, Automated = 2.00).

DIN 8580 process family	FiW	FiC	FiS	FiK	FiH
Shaping	1.82	2.00	1.75	2.00	2.00
Change Material	1.81	1.61	1.78	1.75	1.93
Surface Treatment	1.72	1.56	1.69	2.00	1.64
Forming	1.79	1.44	2.00	1.50	1.50
Separating	1.76	1.48	1.43	1.50	1.71
Joining	1.34	1.39	1.20	1.71	1.22
Weighted Average	1.67	1.55	1.54	1.76	1.72

FiW also shows consistently high automation, reflecting its closer alignment with centralized factory logic. FiC concentrates automation in shaping-related processes, while downstream steps such as joining remain less automated, suggesting that containerized systems prioritize primary core operations. FiS remains moderate overall, implying that retail-linked DMS automate the core production act without fully automating supporting steps. FiH, by contrast, shows weak joining automation (1.22), indicating that delicate or patient-specific late-stage tasks still require greater manual involvement. At product level, the mean automated share is 0.6628 (95% CI: [0.5484, 0.7772]), statistically supporting the automation-leaning profile observed in the sample. Overall, the ranking FiK > FiH > FiW > FiC > FiS, suggests that it is shaped less by process breadth since FiW does not dominate.

Level of Customization. Table 8 shows that FiW is the most standardized archetype overall which is expected given its closeness to the centralized manufacturing logic. FiC, as the second most standardized archetype, suggests that containerized DMS often combines relatively repeatable production structures.

Table 8. Level of Customization Summary Table (Custom=1.00, Standard=2.00).

DIN 8580 process family	FiW	FiC	FiS	FiK	FiH
Forming	2.00	1.72	2.00	1.00	1.00
Surface Treatment	1.84	1.81	1.62	1.71	1.45
Joining	1.89	1.67	1.50	1.59	1.00
Shaping	1.82	1.76	1.58	1.33	1.33
Change Material	1.73	1.81	1.56	1.29	1.27
Separating	2.00	1.44	1.36	1.33	1.14
Weighted Average	1.89	1.70	1.54	1.47	1.25

At the other end, FiH is the most customized archetype, suggesting that hospital-based production is less concerned with throughput-oriented repeatability and more with context-specific response. FiK is also more customized than FiW and FiC, indicating that compact local production is often used where specific demand matters more than strict standardization. FiS presents a mixed profile: it is highly standardized in forming, but only moderate in other families, suggesting that retail-linked DMS may standardize the core make-step while retaining flexibility in surrounding processes. At product level, the mean share is 0.6417 (95% CI: [0.5019, 0.7815]), supporting the standardization-leaning profile, though the interval width reflects meaningful spread across products. Overall, the customization pattern follows the order FiH > FiK > FiS > FiC > FiW, indicating that deployment setting strongly influences the level of customization.

5.2 Clustering of DMS Products

This subsection summarizes the DMS product-side morphology and uses the descriptors to interpret the types of products associated with each archetype: geometry, material, safety, lifetime, personalization, and end-of-life. To support interpretation, geometry is classified as small (S: ≤0.1 m³ and ≤10 kg), mid (M: 0.1–1 m³ and 10–50 kg), or large (L: >1 m³ and >50 kg). Lifetime is classified as short (<5 years), mid (5–10 years), or long (>10 years). The remaining labels are interpreted according to their direct product meaning and are reported in the table legend. Table 9 reports archetype-level counts per descriptor, while Fig. 2 shows the underlying per-product mapping.

Geometry. The sample is dominated by small products (Table 9), indicating that many current DMS applications are more compatible with compact geometries that ease transport, handling, and on-site integration. This pattern is reflected in FiC, FiS, FiK, and FiH, all of which summarize around small products. FiW is the exception, aligning more with large products and suggesting that warehouse-based deployments are better suited to outputs with greater spatial demands, and are therefore closer to CMS factory logic.

Table 9. Product Morphology Summary Table.

Archetype	Geometry			Material				Safety			Lifetime			Personalized		End of life		
	S	M	L	P	B	M	E	D	C	H	S	M	L	S	C	R	D	Ru
FiW	2	1	3	2	1	2	1	4	1	1	2	1	3	5	1	5	0	1
FiC	6	3	1	3	2	3	2	4	3	3	4	4	2	7	3	5	4	1
FiS	5	1	0	4	2	0	0	6	0	0	3	2	1	2	4	3	1	2
FiK	5	0	0	0	2	1	2	1	4	0	2	0	3	3	2	4	1	0
FiH	3	0	0	2	1	0	0	0	3	0	2	0	1	0	3	0	3	0
Legend	Small (S) Mid (M) Large (L)			Polymer (P) Bio-based (B) Metal (M) Electronic (E)				Dust (D) Cleanroom (C) Hazardous (H)			Short (S) Mid (M) Long (L)			Standard (S) Custom (C)		Recycle (R) Dispose (D) Reuse (Ru)		

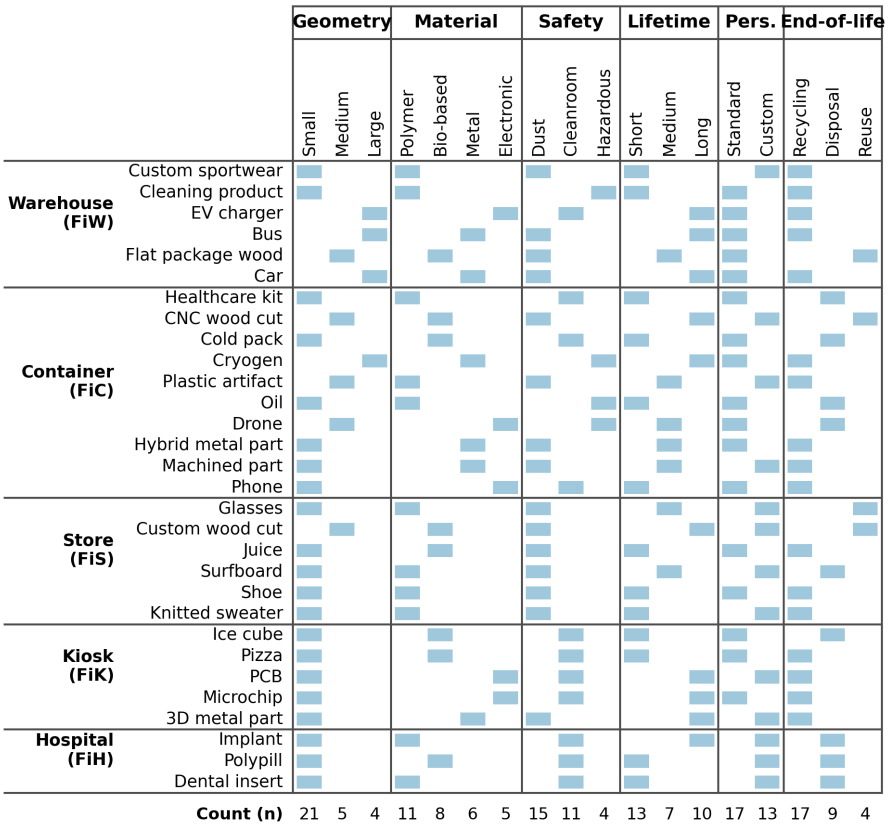

Fig. 2. Expanded product morphology summary across product contexts.

Material. Material choice also shows a selective pattern. Polymer dominates FiC, FiS, and FiH, suggesting that many decentralized cases are associated with materials that do not require the full infrastructural burden of heavier industrial processing. Bio-based materials form the second strongest pattern and remain more application-specific than archetype-defining. FiK stands apart through electronics, while FiW aligns more with metals, indicating also more specialized products in this archetype.

Safety. Dust-related conditions are the most common safety profile, suggesting that many DMS cases still operate in environments shaped by conventional manufacturing concerns such as fabrication, cutting, and material transformation. Table 9 also shows that DMS can extend into more demanding regulatory domains, with cleanroom conditions appearing most clearly in FiK and FiH, consistent with healthcare and food-related applications, while hazardous conditions remain more limited and case-specific.

Lifetime. The coexistence of short and long lifetime products shows that decentralized production is not tied to a single replacement cycle. FiS and FiH summarize around short lifetimes, linking customer-facing and medical settings to immediate-use products. FiC occupies a middle position, while FiW and FiK summarize around longer lifetime products, indicating that DMS can also support longer lifetime outputs .

Personalization. The sample is only slightly more standardized than customized. Standardized products dominate FiW, FiC, and FiK, indicating that many DMS setups still rely on repeatable definitions. Customized products dominate FiS and FiH, suggesting that customer-facing profiles are more associated with user-specific needs.

End-of-life. Recycling is the most common end-of-life pathway in the sample, suggesting that DMS products are often associated with circular recovery pathways. For FiW and FiC, this points to circularity through localized recovery of larger or more technical products, where proximity may reduce the effort needed to return materials into production. For customer-facing archetypes such as FiS and FiK, circularity is more closely linked to localized return, repair, and deposit-based loops because production and consumption occur closer together. Plastic bottle deposit schemes are one example, where proximity enables customers to close the packaging loop through built-in reverse logistics. FiH is the exception, summarizing around disposal, which likely reflects the stricter hygienic and regulatory constraints of hospital-related products.

Overall, the product morphology pattern of largely small, polymer, dust-regulated, standardized, and recycled oriented products indicate that the deployment setting, in this case DMS setups, strongly influences the kinds of products that are produced.

5.3 Summary and Discussion

From an industrial planning perspective, Fig. 3 condenses the descriptor results into a radar-chart screening view. The chart highlights where descriptor tendencies are most pronounced across deployment contexts and makes the extremities easier to see.

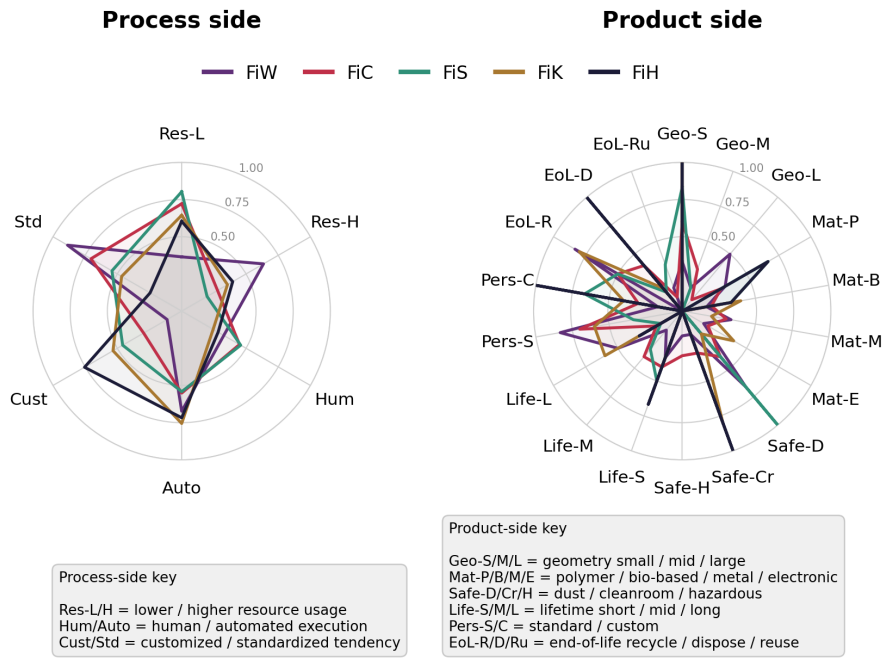

Fig. 3. Summary of process-side (left) and product-side (right) DMS descriptor profiles.

On the process side, FiW shows the clearest pull toward broader, resource-intensive, and standardized processes, consistent with its closer resemblance to conventional factory settings. Automation varies less sharply across archetypes, suggesting that deployment type alone does not strongly determine whether execution is mainly human or machine-led. In contrast, customization becomes more pronounced in FiH, FiK, and FiS, supporting the narrative that moving closer to the customer aligns with customization, whereas FiW remains the most standardized archetype profile, consistent with its greater distance from the customer. For industry, this provides an early filter before detailed planning and implementation.

The product-side results add a complementary screening layer. FiW stands out most strongly on large geometry, long lifetime, standardization, and recycling, consistent with its greater spatial and infrastructural capacity. FiC and FiS both lean toward small products. FiK combines small geometry with stronger cleanroom and electronic-oriented tendencies. FiH is the most distinctive profile, concentrating on small, cleanroom-regulated, customized, and disposal-oriented products.

Archetype suitability does not imply straightforward implementation. FiH requires regulatory, sterilization, and clinical validation controls. FiS and FiK must address consumer safety and public-facing reliability. FiC is constrained by space and utility limits, and FiW may face zoning and permitting challenges. These barriers further support the descriptor profiles as an early screening step before detailed planning begins.

Overall, these descriptor profiles can serve as a rough-planning vocabulary to translate a real product idea into preliminary assumptions about deployment feasibility. For example, a metal maritime component such as a mooring bollard produced via Wire Arc Additive Manufacturing in a containerized setup [24] would, based on the FiC descriptor profile, be expected to show high resource usage, strong automation tendency, and limited process chain breadth. This suggests that standardized product design and automated core processes are practical prerequisites, while extensive customization would likely exceed the spatial and process constraints of the container format. Such early screening before detailed engineering begins is the practical value this descriptor architecture offers to industry planners.

6 Limitations, Conclusion, and Future Work

Several limitations should be acknowledged. First, the sample covers only 30 publicly observable DMS cases and is therefore indicative rather than exhaustive. Second, the study considers decentralized cases only and does not benchmark the same descriptors against centralized manufacturing, so some characteristics may not be unique to DMS. Third, because many companies do not disclose full value streams, parts of the coding rely on public evidence and expert interpretation. The coding was therefore not validated through an independent panel, meaning reliability metrics such as inter-rater agreement were not applied. Finally, while DMS is often linked to sustainability benefits such as reduced transport, the point at which multiple decentralized units lose economies of scale and increase the per-unit energy footprint relative to a centralized equivalent is not captured in this study. The findings should therefore be read as a structured comparative picture of sampled DMS cases rather than universal claims.

This paper contributes a practical descriptor-based workflow for identifying DMS archetypes from heterogeneous evidence. It combines literature-grounded descriptor selection, DIN 8580 process harmonization, aligned coding matrices, and morphological heatmaps to translate fragmented product cases into recurring process-side and product-side patterns. The results indicate that DMS archetypes are distinguishable not only by location format, but also by combinations of process breadth, automation, standardization, and product morphology.

A logical next step is to extend the descriptor architecture into rough-planning use cases by taking a real product candidate and testing whether its product and process descriptors map consistently onto a feasible decentralized setup. This would move the work from descriptive archetype identification toward early configurator logic for DMS planning, including preliminary screening of footprint, utilities, control requirements, and likely deployment form. A further extension would compare decentralized and

centralized cases directly to determine which descriptor patterns are truly distinctive to DMS and which are more general manufacturing-system characteristics.

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