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Digital Transformation of Retail and Distribution Channels in Advanced Manufacturing: An Evidence-Calibrated Framework Applied to Pak Elektron Limited

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Conceptual and Methodological Paper

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Abstract

Public descriptions of digital transformation often reveal customer interfaces more readily than the systems connecting them to production and distribution. This paper develops the Digital Manufacturing-to-Market Ecosystem (DM2ME), a six-domain architecture for examining those connections while recording capability maturity separately from the evidence supporting it. A bounded documentary application to Pak Elektron Limited distinguishes corporate infrastructure from its Appliances and Power businesses. The 2025 annual report describes current enterprise resource planning (ERP) integration, manufacturing information systems, reporting tools and technology governance; these disclosures support corporate-level classifications that cannot be inferred from customer-facing websites alone. Appliances provides observable retail and service interfaces, while Power has a reported digital transformer lifecycle initiative. Dealer integration, division-specific system coverage, predictive-model use and adaptive feedback remain only partly observable. Classifications represent the highest level supported by the available documents, rather than estimates of the firm's actual capability ceiling. The contribution is a transparent procedure for stating what an external assessment can establish, how business-unit scope affects inference, and which evidence would justify a stronger claim. The application illustrates the procedure but does not validate a measurement scale or identify causal performance effects. Independent coding, internal process evidence and comparative fieldwork are required before DM2ME can support maturity benchmarking.

Keywords: Digital transformation; advanced manufacturing; retail and distribution channels; digital maturity; evidence class; dynamic capabilities.

Abbreviations: AI = artificial intelligence; B2B = business-to-business; B2C = business-to-consumer; D2C = direct-to-consumer; DM2ME = Digital Manufacturing-to-Market Ecosystem; ERP = enterprise resource planning; IoT = Internet of Things; KPI = key performance indicator; PEL = Pak Elektron Limited; PSX = Pakistan Stock Exchange; WMS/TMS = warehouse/transportation management system.

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1. Introduction

A manufacturer may accept an online order yet still reconcile stock, dealer allocations and service records manually. Another may operate integrated internal systems while disclosing very little about them. Both situations complicate external assessments of digital transformation. A visible interface establishes that a particular interaction has been digitised; understanding what follows requires

evidence about the information and decisions crossing organisational boundaries.

Digital transformation research places changes in value creation and organisational arrangements alongside technology adoption [1], [2]. Smart-manufacturing research contributes a complementary account of production data, interoperability and coordinated operations [3], [4]. Retail and distribution connect these concerns: production plans depend on market signals, while delivery promises depend on inventory, capacity and execution. Assessing those connections requires more than counting installed technologies or sales channels.

The problem becomes sharper in diversified manufacturers. Consumer appliances commonly involve dealer replenishment, seasonal demand and after-sales service. Power equipment involves specifications, tenders, engineering changes and project delivery. A corporate ERP disclosure may be relevant to both businesses without establishing that every division, product line or external partner uses the same interfaces. An assessment that transfers corporate claims directly to business units can therefore exaggerate coverage. An assessment restricted to public websites can underestimate internal capability.

This paper develops the Digital Manufacturing-to-Market Ecosystem (DM2ME) to make these inference boundaries explicit. Six domains distinguish data preparation, analysis, channel coordination, physical fulfilment, customer or account interaction, and learning. Each assessment records a documented maturity level, source-to-claim evidence class, organisational scope and temporal basis. Missing evidence is recorded as not determinable (ND). A documented level establishes a lower bound on supported capability, not a ceiling on actual capability.

Pak Elektron Limited (PEL) provides a worked application because its Appliances and Power businesses operate under one corporate boundary but serve different markets. Its public documents include financial reporting, technology-governance disclosures, retail and service websites, and a historical ERP announcement [5], [6], [7], [8], [9]. This combination permits an examination of both disclosed capabilities and unresolved interfaces without access to private company systems.

Three research questions guide the analysis. RQ1: Which decision domains distinguish manufacturing-to-market capabilities without counting the same interface repeatedly? RQ2: How can a documentary assessment distinguish capability, disclosure quality and organisational scope? RQ3: What conclusions about PEL are warranted by the identified public records, and which conclusions require additional evidence?

The contribution lies in combining an explicit domain architecture with a conservative documentary coding procedure. The individual domains are established ideas, and the paper makes no claim to a new general theory of digital transformation. DM2ME extends the author's earlier Manufacturing-to-Market practitioner framework [10]. A related manuscript addresses nominal-sales representativeness at PEL [11]; the present analysis concerns digital-capability evidence and does not use sales trajectories to infer maturity. Shared corporate sources provide context rather than independent corroboration between the two papers.

2 Conceptual foundation and framework

2.1 Manufacturing and channel integration

Digital transformation involves changes in organisational activity and value creation, whereas digitisation can be confined to a record or transaction [1], [2]. This distinction matters when translating an installation announcement into a claim about operational capability. Manufacturing reference architectures identify interoperability as a design concern [4], but the presence of an architecture or software product does not demonstrate its use across a particular commercial process. Maturity frameworks also vary in their assumptions about organisational resources and starting conditions [12].

Omnichannel research examines continuity across customer touchpoints and the information needed to coordinate them [13], [14], [15], [16]. For a manufacturer, the relevant channel may include independent dealers whose incentives differ from those of the firm's direct sales operation. Sharing customer identities or stock positions raises questions about access, lead attribution and commercial responsibility. A common database does not by itself settle those questions.

Business-to-business platforms introduce a different set of relationships. Research on manufacturing platforms draws attention to actor roles, trust and governance [17]. In an engineered-product business, the commercially relevant object may be a tender specification or project milestone rather than a retail basket. DM2ME therefore uses channel integration to include dealer, direct-to-consumer, account and project interactions. Physical execution remains a separate domain so that order capture is not counted as evidence of warehouse or production coordination.

2.2 Analytics and operational decisions

Analytics capabilities become operationally consequential when their outputs reach decisions. Research links supply-chain analytics with integration and agility [18], while work on digital resources emphasises governance arrangements [19]. Reviews of artificial intelligence (AI) in supply chains document varied applications and organisational requirements [20], [21], [22]. These studies motivate a distinction between descriptive reporting, predictive models and evidence that either is used in a defined decision process.

A dashboard can support a descriptive-analytics classification without establishing machine learning. A reference to AI oversight can establish a governance commitment without establishing deployment. Similarly, a digital twin requires an identified decision context and links between the represented system and its digital model [23], [24]. DM2ME treats these as separate evidentiary questions. It does not require a digital twin or predictive model in every mature domain.

2.3 Dynamic capabilities and domain boundaries

Dynamic capabilities provide an interpretive connection between information and organisational adaptation. Sensing concerns identifying opportunities and threats; seizing concerns acting on them; reconfiguration concerns changes to assets and routines [25]. Digital transformation can involve repeated renewal of these capabilities [26]. Data and customer interaction can inform sensing, channel and fulfilment processes can enable action, and outcome feedback can support reconfiguration. This mapping is a conceptual rationale, not a set of measured causal relationships.

Figure 1 presents the six-domain loop. The arrows identify relationships to investigate; they do not prescribe a universal implementation sequence. Learning can redirect data collection or decision rules, and customer interaction can occur before, during or after fulfilment. Governance applies across the loop rather than forming a seventh sequential domain.

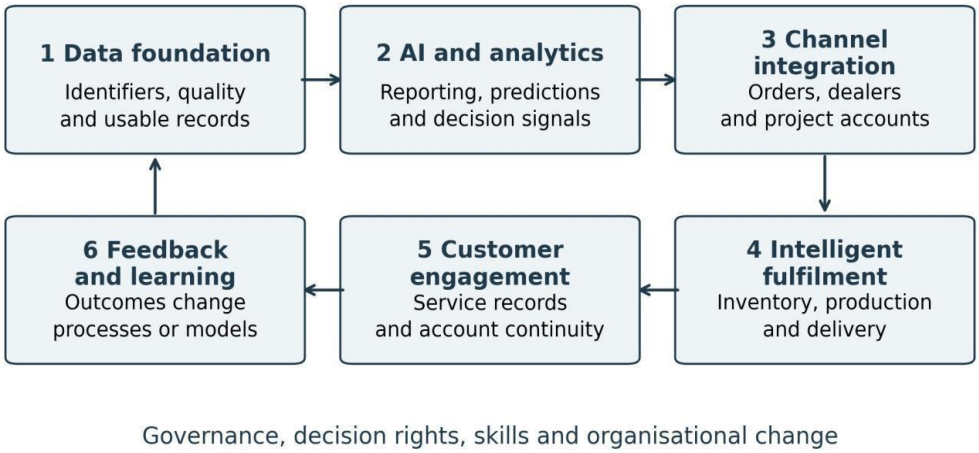


Figure 1. DM2ME conceptual architecture. Arrows indicate potential information relationships, not observed PEL integrations. Governance and organisational change apply throughout.

Table 1 specifies the domains and the evidence needed to distinguish them. A single source may bear on several domains, but each classification requires a different claim about the source. An ERP disclosure, for example, may describe shared data and production coordination; those are separable statements, not two independent corroborating observations.

Table 1. Domain definitions and evidence boundaries.

Domain	Operational definition and indicators	Boundary and literature basis
Data foundation	Usable, linked production and market records; common identifiers, data ownership and lineage.	Ends at making data usable. Reporting or prediction is coded separately [3], [4].
AI and analytics	Descriptive, predictive or prescriptive methods; reports, models, inputs and decision outputs.	Do not infer AI from reporting software or from a governance statement [18], [20], [21].
Channel integration	Digitised commercial interaction and coordination across direct, dealer, account or project channels.	Order capture differs from physical execution; channel scope must be stated [13], [14], [15], [16], [17].
Intelligent fulfilment	Digital coordination of inventory, production, warehousing or delivery.	Requires an execution claim; an e-shop alone is insufficient [16], [27].
Customer or account engagement	Digital service interaction, identity and account continuity; complaint records or service history.	Relationship continuity differs from stock allocation and production execution [13], [14].
Feedback and learning	Outcomes inform documented changes to rules, models or processes.	Reporting is an input to learning, not evidence that adaptation occurred [25], [26].

2.4 Scope and contribution

The central inference rule is that a digital endpoint alone does not establish coordinated operation across adjacent domains. This is a rule of the assessment procedure. Applying it successfully cannot constitute an empirical test of its truth. The case instead demonstrates whether the procedure produces explicit, reviewable classifications when evidence differs in specificity and scope.

The term advanced manufacturing identifies the intended setting: product manufacturing in which engineering, production and market-facing decisions can be linked by digital information. It does not certify PEL's Industry 4.0 maturity or imply that all its facilities use advanced automation. DM2ME is most applicable where several internal functions and external channel actors must coordinate physical products. Its suitability for pure digital platforms or small, single-channel businesses remains untested.

3 Materials and methods

3.1 Research design and case selection

The study combines conceptual synthesis with a bounded documentary application [28], [29]. The literature provides the domain definitions; company-specific records support the application. This is neither a systematic literature review nor a causal evaluation. No survey, interview, site visit, transaction test or independent system inspection is reported.

PEL was selected purposively for the contrast between Appliances and Power and for the availability of public records. Holding corporate ownership and national context in common makes the contrast useful for illustration, but it does not control for differences in management, investment,

process design or disclosure. The case cannot establish the prevalence of a capability among Pakistani manufacturers.

Three levels of scope are retained: corporate infrastructure, Appliances, and Power. A corporate disclosure can support a corporate classification even when unit-level coverage remains ND. Statements about one product process are not extrapolated to an entire division. This scope discipline is particularly important for ERP and manufacturing-execution disclosures.

3.2 Corpus and temporal boundaries

The initial documentary boundary was 2010 to 10 August 2026. Final source verification was conducted on 16 September 2026. Static records retain their stated reporting period; live websites are described as observed on the later date. The current appearance of a webpage is not treated as an archived observation of its August state.

The case evidence comprises five substantive source families: the 2025 annual report, the May 2026 investor briefing, the official e-shop, official service pages, and a 2010 press-release report [5], [6], [7], [8], [9]. The annual report supplies several distinct claim locations, not several independent sources. Company pages and exchange repositories are discovery routes; duplicate copies of the same disclosure are not counted as corroboration. Appendix A lists the sources and locators used for this version.

Inclusion required identifiable provenance and direct relevance to a domain or case baseline. Historical announcements were retained for chronology but excluded as proof of current operation when newer evidence was unavailable. Corporate marketing language was interpreted as issuer reporting, with claimed benefits separated from demonstrated effects. Search snippets, software directories and unsourced commentary were not sufficient for maturity assignment.

Initial retrieval used targeted combinations of PEL with ERP, Oracle, dealer, analytics, warehouse, transport, B2B portal and digital twin. A contemporaneous item-by-item search and exclusion log is not available for this analysis. Consequently, no search yield, screening count or claim of exhaustive retrieval is made. The present source ledger is an explicit audit trail of the records used, not a reconstruction of unobserved historical screening decisions.

3.3 Coding procedure

The unit of coding is a source-to-claim statement at a specified organisational scope. Each record identifies the source date, location, capability claim, domain, evidence class, supported level and inference boundary. The procedure first distinguishes existing capabilities from intentions, then checks whether the evidence identifies an endpoint, an interface, a decision routine or an adaptive loop. Table 2 defines the resulting levels and evidence classes.

Class A means that a current official source directly supports the stated documentary claim. It does not mean that an independent observer has verified implementation. For example, an annual report can directly support the statement that the company reports ERP integration. The operational accuracy of that disclosure remains a separate question. Financial audit assurance is not automatically extended to adjacent narrative technology disclosures.

Class B denotes historical, partial or indirect support. Class C denotes an assumption or interpretation retained for discussion, not evidence sufficient to assign a current level. Where qualifying evidence is missing, the classification is ND. A governance commitment, a vendor's generic feature description and a measured company outcome are coded differently even if they occur in the same paragraph.

Table 2. Documentary maturity anchors and evidence classes.

Code	Meaning	Minimum evidence or interpretation
M1	Documented digitisation	A current, domain-specific digital endpoint, tool or process is described or observable. Actual isolation is not inferred.
M2	Documented coordination	Specific data or workflow exchange connects functions or domains. Record the object and the scope of the connection.
M3	Decision integration	A defined operational decision routine has ownership and monitored performance. Generic efficiency claims are insufficient.
M4	Adaptive operation	Outcome evidence changes rules, models or processes and propagates across relevant interfaces.
ND	Not determinable	The bounded evidence does not establish a level at the specified scope. Not zero and not proof of absence.
A	Direct official evidence	Current issuer or official evidence directly supports the documentary claim; does not imply independent operational assurance.
B	Qualified support	Historical, partial or indirect evidence. Cannot establish an unqualified current level by itself.
C	Interpretation only	Assumption or scenario. No observed maturity level is assigned on this basis.

The M1-M4 levels are ordered anchors proposed for documentary assessment. Their equal spacing, reliability and predictive validity are untested. M1 is labelled documented digitisation, avoiding the stronger claim that the capability is actually isolated. M2 requires a sufficiently specific disclosure connecting functions or domains through a data or workflow object. M3 requires a documented operational decision routine, ownership and performance monitoring. M4 additionally requires evidence that observed outcomes alter the process or model across the relevant interfaces.

The highest level meeting the stated requirements is recorded, together with its scope. Higher levels may exist without being disclosed. A firm-wide maturity score is not calculated, and ND values are never converted to zero. Evidence about corporate systems is shown alongside, rather than silently assigned to, the two embedded business units.

3.4 Interpretation and rival readings

The analysis compares the resulting profiles and identifies evidence that would change each conclusion. A conservative reading asks what remains if issuer descriptions are insufficient to establish operational implementation. A more permissive reading asks whether broadly described interfaces would justify a higher documentary level. These are interpretation checks; they do not add observations or create alternative empirical results.

No inter-coder reliability coefficient is reported. This version checks claims against identifiable source locations, but a source cross-check is not independent coding. The study also lacks member checking and a preserved historical snapshot for every live page. Such limitations affect the strength of the case evidence and are not removed by clearer reporting.

4 Public evidence application to PEL

4.1 Company context and financial terminology

PEL's investor briefing reports 1,513 dealers, 23 sales offices and 524 authorised service centres. It also reports an approximately 80% domestic market share in power transformers and export reach exceeding 30 countries [6, pp. 2, 5, 9-10]. These are issuer-reported contextual figures. Network scale and market share do not establish digital integration.

The briefing reports FY2025 gross sales of PKR 83.530 billion and net sales of PKR 63.524 billion [6, p. 12]. The audited statement reports revenue from contracts with customers of PKR 83,530.003 million and net revenue of PKR 63,523.506 million after sales tax, excise duty and discounts [5, p. H-07]. The rounded values are consistent. Gross and net figures are kept distinct, and neither is used to attribute a performance effect to digitalisation.

4.2 Current corporate technology disclosures

The annual report provides more current and specific technology evidence than the historical announcement alone. Its ERP section describes deployed Oracle E-Business modules, a central database and data exchange across functional areas [5, p. C-20]. A separate section describes integration of materials, inventory, production, operations and accounting, together with manufacturing software, quick-response (QR) serial tracking and Power BI reporting [5, p. C-18]. These disclosures support M2/A for the corporate data foundation and internal fulfilment coordination, and M1/A for descriptive analytics.

The report also describes board-level information technology (IT) oversight, access controls, cybersecurity arrangements, training and consideration of AI initiatives [5, pp. C-15-C-20]. Governance is therefore publicly described. Its effectiveness and division-specific implementation remain untested. The account of AI evaluation does not identify a deployed forecasting model, model performance or a monitored decision pipeline.

These classifications concern documented corporate capability. They do not establish which dealer feeds, customer identifiers, warehouses or division-specific processes participate. Nor do they substantiate the report's broad efficiency claims as causal findings. Table 3 identifies the principal evidence and the limits applied to it.

Table 3. Principal source evidence and inference limits.

Source and locator	What is supported	Inference limit
Annual report [5] C-20; C-18	Deployed ERP, shared data and internal manufacturing coordination; reporting software.	Corporate descriptions do not specify every unit or dealer interface. Narrative technology claims are issuer assertions.
Annual report [5] A-46	A reported transformer digital lifecycle initiative, Design Shelf.	Limited process disclosure; no interface specification or causal performance estimate.
Annual report [5] C-15–C-20	IT oversight, cybersecurity, controls, training and AI evaluation governance.	No evidence that a specific predictive model is deployed or effective.
Investor briefing [6] pp. 2, 5, 9–12	Company scale, network, market position and rounded financial context.	Context only; market reach does not establish digital maturity.
E-shop [7]	Retail catalogue, account and cart interface.	No purchase or back-office transaction test performed.

Source and locator	What is supported	Inference limit
Service page [8]	Complaint access and issuer-described technician workflow.	Cross-domain identity and data exchange not specified.
2010 report [9]	Announcement of ERP selection and planned deployment.	Historical press release; not independent evidence of present operation.

4.3 Appliances and Power

The e-shop displays appliance products, prices, account access and cart functions [7]. This supports an M1/A classification for the Appliances channel domain. No purchase was made, and payment processing or fulfilment was not tested. Public interface inspection does not reveal dealer inventory synchronisation or the treatment of an online order in the ERP system.

Official service pages describe complaint handling, status updates and technician tasks [8]. These statements warrant more than describing the service environment as a static contact page, but they do not establish how service records connect to product, warranty or production data. The conservative classification is M1/A for customer engagement, with a reported service workflow that merits further investigation. A higher rating would require a sufficiently specified adjacent-domain interface, not merely a description of roles within the application.

For Power, the annual report identifies Design Shelf as an initiative covering the transformer process from inquiry to billing [5, p. A-46]. It therefore supports M1/A for a defined digital commercial-process capability. The short disclosure does not identify the data objects, connected systems or controls needed to substantiate M2 for cross-domain orchestration. It also cannot establish coverage across all Power products. This evidence rules out the blanket statement that Power has no publicly documented digital process.

Figure 2 distinguishes historical evidence from the current reporting basis. The 2010 announcement records software selection and intended implementation [9]. Current ERP claims rest on the 2025 annual report, so no assumption of uninterrupted continuity from 2010 is necessary.

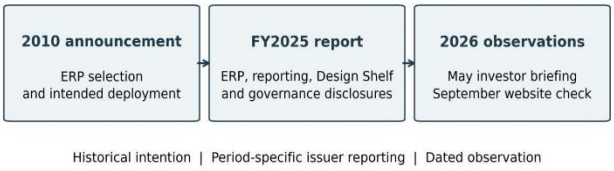


Figure 2. Documentary chronology. The historical announcement, annual-report disclosures and live interface observations have different temporal meanings; dates do not imply uninterrupted system continuity.

4.4 Supported configuration and interpretation checks

Table 4 reports the supported configuration. Corporate integration disclosures coexist with unresolved interfaces at the division and partner levels. The profile is therefore more informative than either a technology inventory or a single firm-wide score. It recognises current enterprise capabilities while retaining uncertainty about how far they extend into market-facing processes.

Table 4. Highest documentary level supported at each scope.

Domain	Corporate infrastructure	Appliances	Power
Data foundation	M2/A ERP data integration	Unit-specific coverage ND	Unit-specific coverage ND
AI and analytics	M1/A Descriptive reporting	Unit-specific use ND	Unit-specific use ND
Channel integration	No separate corporate rating	M1/A E-shop interface	M1/A Transformer Design Shelf
Intelligent fulfilment	M2/A Internal coordination	External and unit coverage ND	External and unit coverage ND
Customer engagement	No separate corporate rating	M1/A Digital service access	Dedicated account capability ND
Feedback and learning	ND	ND	ND
Governance	Not a scored domain Current arrangements reported	Local operation untested	Local operation untested

Two interpretation checks clarify the classification. First, if operational maturity were restricted to independently inspected systems, the corporate M2 entries would become unverified operational claims while remaining direct documentary disclosures. The study would then describe what PEL reports, without assigning independently verified operational levels. This alternative demonstrates why evidence provenance must remain visible beside every maturity label.

Second, a permissive reading could interpret Design Shelf's inquiry-to-billing coverage, or the service application's role coordination, as sufficient for M2. The present coding retains M1 because the disclosed interface objects and adjacent-domain connections are underspecified. Neither interpretation supplies model validation, decision-performance records or adaptive outcome loops. M3 and M4 remain unsupported by the bounded corpus. This is a limit of inference, not evidence that such capabilities are absent.

The distinction between corporate and unit scope remains material under both readings. A corporate database description cannot resolve which external dealer systems participate. Likewise, a transformer process disclosure cannot establish integrated retail service operations. These are concrete questions for subsequent fieldwork rather than grounds for ranking one business as more digitally mature than the other.

5 Discussion

5.1 What the documentary application contributes

The application answers RQ1 through the domain boundaries in Table 1 and RQ2 through the separation of level, provenance, scope and time. For RQ3, it establishes a set of current issuer-reported enterprise capabilities and specific market-facing processes while identifying the interfaces that remain unclear. Its empirical contribution is the documented application of an inference procedure, not a validated explanation of digital transformation success.

One practical lesson is that incomplete source reading can resemble genuine non-disclosure. Had the annual report been used only for financial figures, several digital capabilities would have been incorrectly classified as lacking current public evidence. ND should therefore be attached to a clearly bounded corpus and reviewed when relevant source sections become available. A conservative code is defensible only when the search and reading underlying it are transparent.

A second lesson concerns levels of analysis. Enterprise integration and partner integration are different propositions. ERP modules may exchange information internally while independent dealers continue to report stock through other means. Conversely, a division may operate an effective specialist application whose interfaces are poorly described at corporate level. Separating scopes prevents either possibility from being lost in an aggregate label.

5.2 Decision mechanisms and illustrative examples

The dynamic-capabilities interpretation identifies questions that transaction or process evidence could answer. When a demand signal changes allocation, the researcher can inspect how information informs action. When recurring service failures change design or replenishment rules, the researcher can investigate adaptation. The present disclosures do not trace either chain, so the theoretical mapping remains provisional [25], [26].

Consider an illustrative appliance order that reserves stock in a warehouse but leaves a dealer's available balance unchanged. Order capture and internal fulfilment could both be digital while the dealer interface remains fragmented. An interface assessment would examine identifier matching, update timing and responsibility for conflicting allocations. This example is hypothetical and is not presented as a PEL observation.

A second hypothetical example concerns transformer specifications. If a customer's revised requirement updates a quotation but not the engineering bill of materials, a digital tender record has not established end-to-end coordination. Evidence of a controlled revision passing from the commercial record to engineering and production would support a stronger interface claim. Figure 3 organises these different objects for future investigation.

A service example illustrates the additional requirement for learning. Recording repeated compressor complaints may support reporting, but an adaptive loop requires evidence that analysis changed a service rule, spare-parts decision or product process, followed by review of the consequence. A meeting note or dashboard alone cannot show that the change occurred. These examples operationalise the framework's distinctions without adding invented case results.

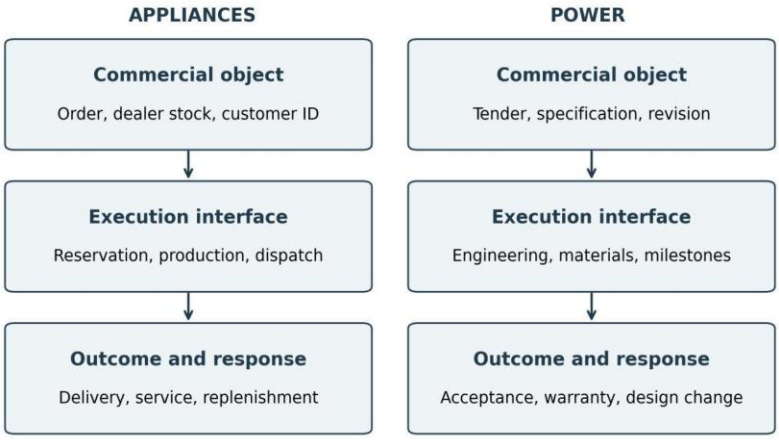


Figure 3. Interfaces for future validation. The two pathways identify candidate information objects for Appliances and Power. They are research questions, not a depiction of PEL's installed systems.

5.3 Governance and performance measurement

Governance determines who can access information, resolve conflicts and authorise changes across the domains. Research on supply-chain integration identifies organisational compatibility and information sharing as substantive concerns [27]. Digital-resource governance also warrants attention when explaining variation in integration

[19]. In PEL's case, governance arrangements are described, but their effectiveness cannot be inferred from disclosure alone.

Capabilities and outcomes require separate evidence. A walkthrough may establish that two systems exchange an order identifier; it does not show that the interface improves delivery reliability. A performance study would need a defined population, baseline, observation period and treatment of concurrent changes. It should also retain adverse outcomes and manual workarounds rather than selecting successful transactions only.

Table 5 translates the unresolved claims into a validation agenda. The measures are candidates, not reported PEL results or investment priorities. Forecast error, delivery reliability and service performance should be chosen for the decision context and measured consistently before and after any intervention where a longitudinal design is feasible.

Table 5. Evidence required for subsequent validation.

Domain or question	Primary evidence to obtain	Candidate measures
Data and interfaces	Current system map, identifier definitions, interface logs and unit coverage; reconcile samples of exchanged records.	Missing or mismatched records; update latency; coverage.
Channel coordination	Trace an appliance order and a transformer inquiry through adjacent systems, including failed or manually corrected cases.	Order accuracy; quotation lead time; exception frequency.
Fulfilment	Trace stock reservations, production release, dispatch and delivery; identify manual workarounds.	On-time in-full delivery; schedule adherence; inventory turns.
Analytics	Identify deployed reports and models, owners, decision use, monitoring and overrides.	Forecast error and bias; override rate; decision adoption.
Service and learning	Link complaint history to corrective action and subsequent review of the outcome.	Resolution time; first-time fix; repeated failure; time to corrective action.
Governance	Inspect access reviews, responsibility assignments, training records and incident follow-up.	Control exceptions; adoption; unresolved access or quality issues.

5.4 Validation and limitations

DM2ME has not undergone expert content validation, independent coding or multi-case measurement testing. The level anchors therefore remain a proposed assessment language. A first validation study should ask experts to assess domain coverage, overlaps and the minimum evidence required for each transition. Disagreements would identify rules needing revision before a larger coding exercise.

Independent coders should then classify the same frozen source corpus without access to one another's decisions. Raw agreement and a suitable chance-adjusted statistic should be reported separately for domains, organisational scope and levels, with ND handled explicitly. Sparse categories or very frequent ND classifications can make a single coefficient misleading. No sample size or reliability value is claimed here.

Fieldwork should trace selected transactions across commercial, production, delivery and service processes. System logs, process owners and exceptions can

corroborate or qualify issuer statements. A comparative design should include firms and units with different disclosure practices so that observable transparency is not mistaken for superior capability. Performance hypotheses would require an adequately justified sampling and identification strategy beyond this illustrative study.

The present work also has source limitations. Corporate records are selective and may contain promotional descriptions. Websites change, historical snapshots are incomplete, and narrative technology sections do not carry the same assurance as audited financial statements. The source corpus is purposive rather than exhaustive. Author industry experience informs interpretation, while the disclosed professional relationship creates a reason to retain explicit provenance and rival readings. None of these constraints supports causal, population-level or investment-return claims.

6 Conclusion

The PEL application shows why digital-capability assessment needs both careful source reading and explicit inference rules. Current corporate disclosures support an enterprise data and internal coordination foundation, while retail, service and transformer-process evidence identify more specific applications. The remaining uncertainty concerns interface coverage, operational use and adaptive feedback rather than a wholesale absence of public digital evidence.

DM2ME contributes six decision domains and a procedure that keeps supported capability, evidence provenance, organisational scope and time visible. Its use is presently limited to structured documentary interpretation and the design of subsequent validation. Independent process evidence and comparative research are needed before the framework can justify maturity rankings or claims about performance.

Declarations

Ethics. The analysis uses public corporate documents and public website content. No human-participant study, private correspondence or personal-level dataset was conducted or collected. No institutional ethics approval is claimed.

Data availability. Source references, page locators, the coding matrix and decision rules are included in this manuscript and its appendices. No separate historical replication archive or complete original search log is claimed. Third-party source documents remain available through the cited publishers and issuer websites, subject to changes in access.

Funding. This research received no external funding.

Positionality and competing interests. The author reports prior senior regional commercial responsibility at Panasonic, which had a partnership with PEL during the relevant period. The author reports no current financial, advisory or employment relationship with PEL, no internal PEL access for this study, and no PEL review or influence over the analysis. The study relies on public records.

AI assistance. OpenAI ChatGPT assisted with substantive editorial revision, source checking, methodological clarification, tables, diagrams and document preparation. AI assistance was not used to collect private company data or to conduct independent empirical validation. The author remains responsible for verifying the final analysis, references and declarations and for complying with the receiving journal's disclosure requirements.

References

1. G. Vial, “Understanding digital transformation: A review and a research agenda,” The Journal of Strategic Information Systems, vol. 28, no. 2, pp. 118-144, 2019. https://doi.org/10.1016/j.jsis.2019.01.003
2. P. C. Verhoef, T. Broekhuizen, Y. Bart, A. Bhattacharya, J. Q. Dong, N. Fabian, and M. Haenlein, “Digital transformation: A multidisciplinary reflection and research agenda,” Journal of Business Research, vol. 122, pp. 889-901, 2021. https://doi.org/10.1016/j.jbusres.2019.09.022
3. F. Tao, Q. Qi, A. Liu, and A. Kusiak, “Data-driven smart manufacturing,” Journal of Manufacturing Systems, vol. 48, pp. 157–169, 2018. https://doi.org/10.1016/j.jmsy.2018.01.006
4. M. Moghaddam, M. N. Cadavid, C. R. Kenley, and A. V. Deshmukh, “Reference architectures for smart manufacturing: A critical review,” Journal of Manufacturing Systems, vol. 49, pp. 215-225, 2018. https://doi.org/10.1016/j.jmsy.2018.10.006
5. Pak Elektron Limited, Annual Report 2025, 2026. https://pel.com.pk/wp-content/uploads/2026/04/Pak-Elektron-Limited-Annual-Report-2025.pdf (accessed Sep. 16, 2026).
6. Pak Elektron Limited, Investor Briefing, May 19, 2026. https://pel.com.pk/wp-

content/uploads/2026/05/PEL-CBSPresentation-2025.pdf (accessed Sep. 16, 2026).
7. Pak Elektron Limited, "PEL e-shop." https://eshop.pel.com.pk/ (accessed Sep. 16, 2026).
8. Pak Elektron Limited, "Khidmat Markaz." https://pel.com.pk/khidmat-markaz/ (accessed Sep. 16, 2026).
9. Business Recorder, "PEL to deploy Oracle application for streamlining services," Jul. 21, 2010 [press-release report]. https://www.brecorder.com/news/3783421 (accessed Sep. 16, 2026).
10. K. Pitafi, The Manufacturing-to-Market Framework (M2M): Connecting Production, Distribution, and Commercial Growth, practitioner monograph, 2024. Bibliographic details supplied by the author; no public identifier provided.
11. K. Pitafi, Portfolio Recovery Asymmetry in Nominal Sales, unpublished manuscript, 2026.
12. S. Mittal, M. A. Khan, D. Romero, and T. Wuest, "A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs)," Journal of Manufacturing Systems, vol. 49, pp. 194–214, 2018. https://doi.org/10.1016/j.jmsy.2018.10.005
13. P. C. Verhoef, P. Kannan, and J. J. Inman, "From Multi-Channel Retailing to Omni-Channel Retailing," Journal of Retailing, vol. 91, no. 2, pp. 174-181, 2015. https://doi.org/10.1016/j.jretai.2015.02.005
14. D. Herhausen, J. Binder, M. Schoegel, and A. Herrmann, "Integrating Bricks with Clicks: Retailer-Level and Channel-Level Outcomes of Online-Offline Channel Integration," Journal of Retailing, vol. 91, no. 2, pp. 309-325, 2015. https://doi.org/10.1016/j.jretai.2014.12.009
15. S. Saghiri and V. Mirzabeiki, "Omni-channel integration: the matter of information and digital technology," International Journal of Operations & Production Management, vol. 41, no. 11, pp. 1660-1710, 2021. https://doi.org/10.1108/IJOPM-04-2021-0262
16. M. M. Pereira and E. M. Frazzon, "A data-driven approach to adaptive synchronization of demand and supply in omnichannel retail supply chains," International Journal of Information Management, vol. 57, Art. no. 102165, 2021. https://doi.org/10.1016/j.ijinfomgt.2020.102165
17. L. Compagnucci, F. Spigarelli, P. Sernani, E. Frontoni, and P. Seri, "A systematic literature review of business-to-business platforms for the digital transformation of the manufacturing industry: taking stock and advancing through research," Technovation, vol. 148, Art. no. 103330, 2025. https://doi.org/10.1016/j.technovation.2025.103330
18. L. Cui, Z. Wang, Y. Liu, and G. Cao, "How does data-driven supply chain analytics capability enhance supply chain agility in the digital era?," International Journal of Production Economics, vol. 277, Art. no. 109404, 2024. https://doi.org/10.1016/j.ijpe.2024.109404
19. C. W. Franco, G. B. Benitez, P. R. de Sousa, F. J. Kliemann Neto, and A. G. Frank, "Managing resources for digital transformation in supply chain integration: The role of hybrid governance structures," International Journal of Production Economics, vol. 278, Art. no. 109428, 2024. https://doi.org/10.1016/j.ijpe.2024.109428
20. G. Culot, M. Podrecca, and G. Nassimbeni, "Artificial intelligence in supply chain management: A systematic literature review of empirical studies and research directions," Computers in Industry, vol. 162, Art. no. 104132, 2024. https://doi.org/10.1016/j.compind.2024.104132
21. R. Toorajipour, V. Sohrabpour, A. Nazarpour, P. Oghazi, and M. Fischl, "Artificial intelligence in supply chain management: A systematic literature review," Journal of Business Research, vol. 122, pp. 502-517, 2021. https://doi.org/10.1016/j.jbusres.2020.09.009
22. G. Shahzadi, F. Jia, L. Chen, and A. John, "AI adoption in supply chain management: a systematic literature review," Journal of Manufacturing Technology Management, vol. 35, no. 6, pp. 1125-1150, 2024. https://doi.org/10.1108/JMTM-09-2023-0431
23. D. Ivanov and A. Dolgui, "A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0," Production Planning & Control, vol. 32, no. 9, pp. 775-788, 2021. https://doi.org/10.1080/09537287.2020.1768450
24. S. A. H. Zaidi, S. A. Khan, and A. Chaabane, "Unlocking the potential of digital twins in supply chains: A systematic review," Supply Chain Analytics, vol. 7, Art. no. 100075, 2024. https://doi.org/10.1016/j.sca.2024.100075
25. D. J. Teece, "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance," Strategic Management Journal, vol. 28, no. 13, pp. 1319-1350, 2007. https://doi.org/10.1002/smj.640

26. K. S. Warner and M. Wäger, "Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal," Long Range Planning, vol. 52, no. 3, pp. 326-349, 2019. https://doi.org/10.1016/j.lrp.2018.12.001

27. F. Bodendorf, S. Dentler, and J. Franke, "Digitally enabled supply chain integration through business and process analytics," Industrial Marketing Management, vol. 114, pp. 14-31, 2023. https://doi.org/10.1016/j.indmarman.2023.07.005

28. G. A. Bowen, "Document Analysis as a Qualitative Research Method," Qualitative Research Journal, vol. 9, no. 2, pp. 27–40, 2009. https://doi.org/10.3316/QRJ0902027

29. R. K. Yin, Case Study Research and Applications: Design and Methods, 6th ed. SAGE, 2018

Appendix A Source and claim register

The following register identifies the evidence used in this version. Page references prefixed A, C or H are printed annual-report page labels; PDF ordinals are supplied to make the locations easier to recover. Website observations refer to 16 September 2026. The register does not imply that an independent observer tested the described systems.

E1 Annual report 2025 [5], H-07, PDF p. 260

Financial context. Revenue and net revenue; financial statement, not a digital-capability result.

E2 Annual report [5], C-20, PDF p. 109

Source scope. ERP is described across departments. Division and external-partner coverage are not enumerated.

E3 Annual report [5], C-20, PDF p. 109

Data foundation M2/A, corporate. Current ERP modules, common data structure and cross-functional data flow.

E4 Annual report [5], C-18, PDF p. 107

Fulfilment M2/A, corporate. Materials, inventory, production and operations are described within an integrated information environment; implementation not independently inspected.

E5 Annual report [5], C-18, PDF p. 107

Analytics M1/A, corporate. Power BI reporting is identified. Predictive models, validation and decision routines are not identified.

E6 Annual report [5], A-46, PDF p. 65

Channel M1/A, Power transformer process. Design Shelf is described from inquiry to billing. Conservative M1 because connected objects and systems are not specified.

E7 Annual report [5], C-15-C-20, PDF pp. 104-109

Governance, unscored. IT oversight, controls, training and AI evaluation are described; their effectiveness is not tested.

E8 Investor briefing [6], PDF pp. 2, 5, 9-12

Context only. Network scale, market position, export reach and rounded financial measures.

E9 Official e-shop [7], product, account and cart areas

Channel M1/A, Appliances. Visible retail interface. No completed order, payment or fulfilment test.

E10 Khidmat Markaz [8], application description and support links

Engagement M1/A, Appliances. Complaint access and reported service-role workflow. No verified product or ERP interface.

E11 Business Recorder [9], 21 July 2010 report

B, historical context. Selection announcement for Oracle E-Business Suite Release 12; does not establish implementation at that date.

E12 Bounded corpus [5], [6], [7], [8], [9]

ND for unresolved claims. No sufficient record of division-specific predictive decision routines or adaptive commercial-to-production loops. This is corpus-limited missingness.

Appendix B Reusable coding and validation procedure

B1 Required record fields

For each candidate claim, record a stable source ID, title, URL or identifier, publication or reporting date, observation date, page or section, a short factual paraphrase, organisational unit, domain, claimed capability, documentary or operational verification basis, evidence class, supported level, unresolved boundary and coder rationale. Preserve the original file or a lawful dated snapshot where feasible. Record duplicate-source relationships so that repeated corporate text is not counted as independent evidence.

B2 Decision sequence

First determine whether the statement concerns a current implemented capability, a historical event, a plan or a generic software feature. Next identify its organisational scope and the relevant domain. Verify that the source directly supports the claimed endpoint or process before assigning M1. Assign M2 only when the disclosure specifies a data or workflow connection across functions or domains. A corporate connection remains corporate unless unit coverage is stated or separately evidenced.

For M3, seek a named decision routine, accountable role and monitored performance evidence. For M4, seek a documented change driven by outcomes and evidence that the change propagates across the relevant interfaces. Failure to meet a higher threshold does not refute that capability; record the highest supported level and the missing evidence. Record ND where even the lower-level claim lacks adequate support. Keep assumptions outside the observed coding matrix.

B3 Worked coding decisions

E3 in Appendix A supports corporate data foundation at M2/A because it describes current ERP modules and a common data structure that connects functions. The same record does not support a dealer-integration rating: an external dealer feed is not identified. E5 supports descriptive analytics at M1/A because Power BI reporting is described, but it does not identify a predictive model. E6 supports a Power digital-process entry at M1/A, limited to the transformer initiative; inquiry-to-billing wording alone does not expose the interfaces required for M2 under the conservative rule.

B4 Disconfirming evidence and revision

Later evidence may narrow a claim to a pilot or reveal manual reconciliation. Transaction traces may also establish integration where public evidence supports only M1 or ND. Retain superseded coding decisions and explain changes; the initial documentary level is not a fixed property of the firm.