International Journal of Computer Trends and Technology
ISSN: 2231–2803 / https://doi.org/10.14445/22312803/IJCTT-V74I4P101

Volume 74 Issue 4, 1-9, April 2026

Original Article

Toward a Maturity-Based Framework for Transportation Visibility: Diagnosing Organizational Readiness in SAP Transportation Management Implementations

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Received: 24 February 2026 Revised: 29 March 2026 Accepted: 12 April 2026 Published: 27 April 2026

Abstract *- Companies that spend money on enterprise transportation management systems often find that the visibility they expect does not match the technology they have put in place. This paper contends that the issue does not stem from the platforms themselves, which have undergone substantial enhancement, but rather from the organizational conditions that determine the effective utilization of these platforms. Based on a structured review of the literature on supply chain management and evidence from the implementation of SAP Transportation Management (SAP TM) in the SAP S/4HANA environment, this study presents the Logistics Visibility Maturity (LVM) framework. The LVM framework is a diagnostic tool that measures an organization's readiness in three areas: transportation planning transparency, shipment execution monitoring, and logistics analytics usage. The LVM framework shows a four-level maturity progression that helps organizations figure out where they are now, what gaps are keeping them from full visibility, and how to make targeted improvements. The results show that the most important change is not going from having no system to having one, but from just having a system to using it regularly. This is a detail that is often missed in current implementation guides. The framework offers a theoretical advancement in supply chain visibility research and a pragmatic approach for logistics organizations implementing TMS.*

Keywords *- Digital Supply Chain Transformation, Logistics Visibility Maturity, Organizational Readiness, SAP Transportation Management, Transportation Management Systems, Visibility Framework.*

1. Introduction

When companies manage freight operations across big networks, they often feel like they have a lot of data but not much insight. Even with strong tracking portals, carrier milestone events, and TMS exception alerts, important questions like what is happening with shipments right now and why shipment problems happen often go unanswered. This paper talks about the gap that often exists between the large amount of transportation data and the level of transparency that businesses want. This paper discusses the gap between how easy it is to get data and how open operations are. This is not a new problem. For decades, supply chain scholars have looked into logistics visibility, and enterprise TMS platforms have gotten a lot better in that time. A more subtle and long-lasting barrier that has not gotten as much attention is the organizational conditions that decide whether a certain amount of money spent on technology leads to the same level of operational visibility.

This is a simple argument. Transportation management platforms like SAP TM have a technical limit on visibility, which is the highest level of transparency that the system design can handle. However, how much of that limit an organization actually reaches depends on how mature it is. If one organization has spent money on process discipline, data governance, and analytical skills that let the system work as it should, while the other has not, the visibility results for the two organizations using the same TMS setup can be very different.

This is not a new finding in the field of enterprise systems research. The literature on information systems has long known that adopting technology and using it are two different things, and that the difference between them is based on organizational factors [10]. There is a lack of a structured framework in the transportation management literature that offers logistics professionals and researchers a shared terminology for evaluating that gap—an approach to determine not only if an organization possesses a TMS but also the efficacy of its utilization. This paper fills that gap by suggesting the Logistics Visibility Maturity (LVM) framework. The framework looks at how well an

organization can see its transportation across three areas: planning transparency, execution monitoring, and analytics use. It does this at four levels of maturity, from Fragmented to Predictive. It is meant to be a diagnostic tool that an organization can use before, during, or after a TMS implementation to find out how things are going and where they need to improve.

2. Literature Review and Theoretical Background

2.1. Supply Chain Visibility: What It Is and Why It Remains Elusive

People often define supply chain visibility as how well people in a supply network can get timely and accurate information about what is going on in that network [1]. In transportation, visibility means being able to follow freight from its starting point to its final destination, find problems before they become failures, and react to delays with enough time to keep downstream commitments [3]. That definition seems easy to understand. In reality, it is very hard to do. One reason is technical: transportation data comes from many systems, carriers, and places that do not naturally share a common data model. The other reason is organizational. Bowersox, Closs, and Cooper [9] characterize the organizational dimension as a coordination challenge: visibility necessitates that various functions, such as logistics, procurement, operations, and customer service, share data and respond in a unified manner. Building that kind of cross-functional coordination is harder than putting together software.

Helo and Hao [8] have recently focused on a different aspect of the problem: the ability to act on visibility data, as opposed to the ability to create it. Their research on artificial intelligence in supply chain operations indicates that numerous organizations currently possess an excess of logistics data that exceeds their capacity for meaningful processing. In this context, the limitation on visibility is not due to a lack of data, but rather to a lack of analytical and organizational capacity. Planning and operations research has long known that having a lot of information but not being able to understand and act on it leads to diminishing returns instead of increasing ones. This is especially true in complex transportation networks [13], [1]. These observations highlight a fundamental distinction within the LVM framework: the disparity between visibility capability (the technological support) and visibility realization (the actual organizational outcomes). Most of the current literature concentrates on the former. This paper is about the second one.

2.2. Transportation Management Systems and the Implementation Gap

Over the past 20 years, enterprise TMS platforms have changed a lot. Early systems were mostly about booking freight and keeping track of carrier rates. Modern platforms like SAP TM help with all parts of the transportation process, such as managing freight orders, optimizing routes for multiple modes of transportation, managing carrier tenders, tracking shipments based on events, and advanced transportation analytics [5], [4].

Even with these improvements, the results of implementation are still very different. Surveys of practitioners and research in the industry show that TMS deployments consistently fall short of expected results. Implementation reports have clearly shown what went wrong: poor change management, poor master data quality, and a mismatch between how the system was set up and how it was actually used [16], [17]. These are not technical problems; they are problems with the way the organization and processes work. The platforms themselves are not usually the main reason why visibility outcomes are not good.

A surprising finding from industry analysis is that the difference in performance between high- and low-performing TMS implementations is more due to how ready the organization is than which platform it chooses. Research and consulting firms that keep an eye on how businesses use enterprise logistics technology consistently find that companies with more mature processes and better data governance see much bigger improvements in transportation costs and delivery performance than companies with less mature processes. This difference cannot be explained by which platform was chosen [6], [16]. It is clear what this means: it is more important for an organization to be ready to use a TMS than which one it chooses. However, the current advice on how to use TMS does not give a clear way to check or improve that readiness.

The LVM framework is meant to fill this gap.

2.3. Maturity Frameworks in Supply Chain and Logistics Research

There is a well-known place for maturity models in supply chain research and practice. The Supply Chain Operations Reference model gives a maturity rating for each step in the plan, source, make, deliver, and return process. More recently, digital supply chain maturity models have been created to see how ready a company is for Industry 4.0 technologies. One of the most widely used frameworks in this area is Hofmann and Rüsch [12].

In logistics technology, maturity Frameworks have been utilized in warehouse management, demand forecasting, and inventory optimization. The author is unaware of any established maturity framework specifically designed for transportation visibility capabilities. The digital supply chain maturity models mentioned above and the CSCMP's global visibility reporting [7] are the most similar. The latter talks

about visibility levels but does not give organizations a way to assess themselves.

The LVM framework suggested here is based on this research, but also fills in the gaps. It is tailored for visibility, applicable to practitioners, and structured to evaluate not only technology implementation but also the organizational factors that influence the realization of intended technological outcomes.

3. Research Framework and Methodology

3.1. Conceptual Model

The research is based on a conceptual framework where achieved transportation visibility depends on three organizational dimensions, all of which need to mature adequately for the others to be effective. This relationship can be written as:

$$V = f(P, E, A \mid M)$$

where V = realized visibility, P = planning transparency, E = execution monitoring, A = analytics utilization, and M = organizational maturity conditions

This model is different from other technology-focused frameworks because it includes M as a mediating condition. Organizational maturity is not a background variable; it actively determines the extent to which the P, E, and A capabilities offered by a platform such as SAP TM translate into operational visibility. A company with a high M will get a lot more visibility from a certain TMS setup than a company with a low M using the same system.

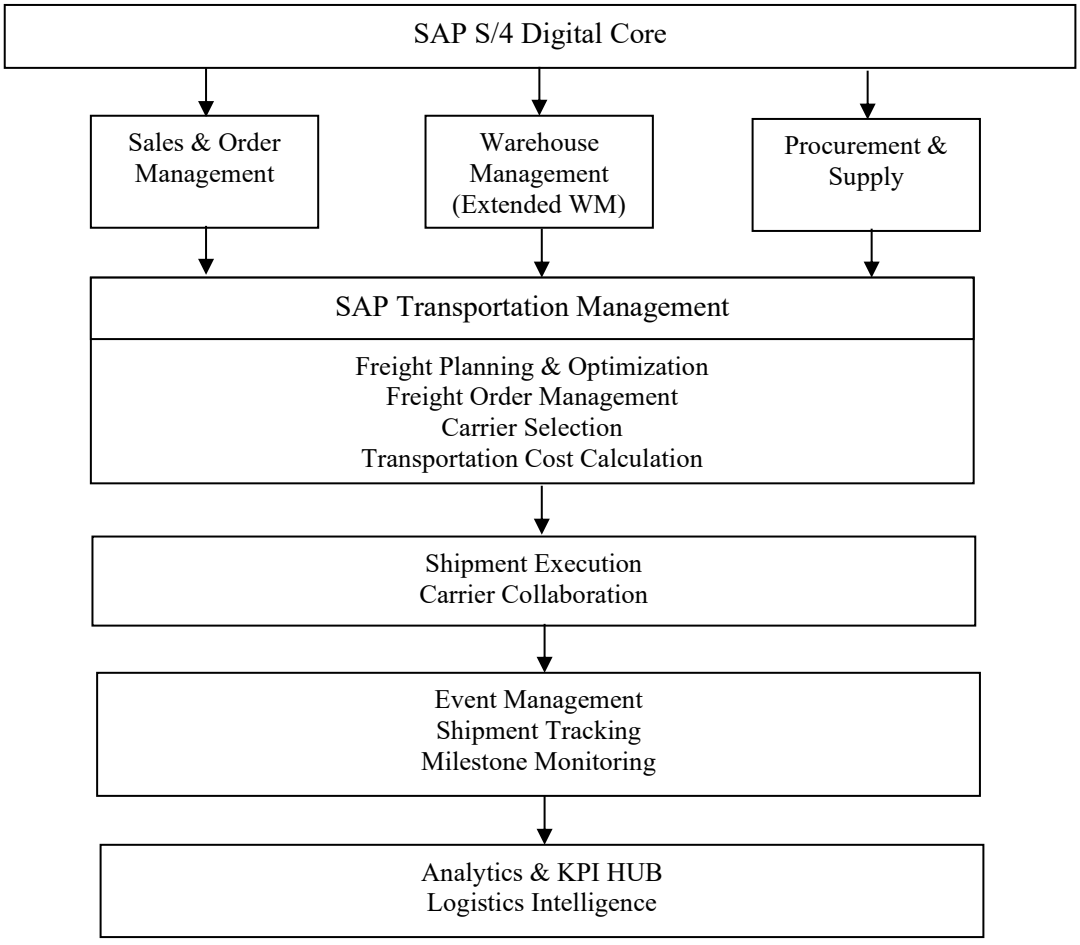

Fig. 1 Architecture of SAP Transportation Management for Integrated Logistics Visibility, with Logistics Visibility Maturity (LVM) dimension overlay

3.2. Methodology

The research utilizes a structured literature synthesis methodology. The review protocol included searches of the Scopus, Web of Science, and EBSCOhost databases using the search terms "Transportation Management System," "Supply Chain Visibility," "Logistics Information Systems," and "TMS implementation outcomes." The search was limited to peer-reviewed journal articles, practitioner research reports, and enterprise software documentation published between 2015 and 2024. An initial pool of 187 sources was evaluated based on inclusion criteria that mandated relevance to transportation visibility, logistics

technology, or organizational preparedness within supply chain contexts. The framework was built using information from seventy-three sources that met these standards.

There were three steps in building the LVM framework. Initially, visibility dimensions were discerned and delineated based on converging themes within the literature.

Second, maturity indicators for each dimension were put into action by using evidence from SAP TM deployments and the organizational readiness factors found in the literature on enterprise systems. Third, the four-level progression structure was confirmed by comparing it to documented implementation patterns found in practitioner sources, such as [6], [7], [5], and [11].

The framework that comes out of this is meant to be a starting point for future empirical validation. The author's professional background in supply chain and logistics operations contributed to the practitioner relevance of the maturity indicators. Nonetheless, this paper refrains from making empirical assertions derived from that experience; the framework is established upon the published literature.

4. The Logistics Visibility Maturity (LVM) Framework

4.1. Framework Overview

The LVM framework assesses organizational transportation visibility across three dimensions -Planning Transparency (P), Execution Monitoring (E), and Analytics Utilization (A) -at four maturity levels: Fragmented (Level 1), Emerging (Level 2), Integrated (Level 3), and Predictive (Level 4).

One thing to keep in mind about the framework is that organizations are judged on each dimension instead of getting a single score. In reality, maturity is seldom consistent. Many companies have spent a lot of money on carrier connectivity and do a great job of monitoring execution. Their planning processes are still mostly done by hand, and they do not really use analytics at all. A single maturity score would hide this profile and suggest general ways to improve that do not address the real gaps. Dimension-level assessment allows for more accurate diagnosis and more focused intervention.

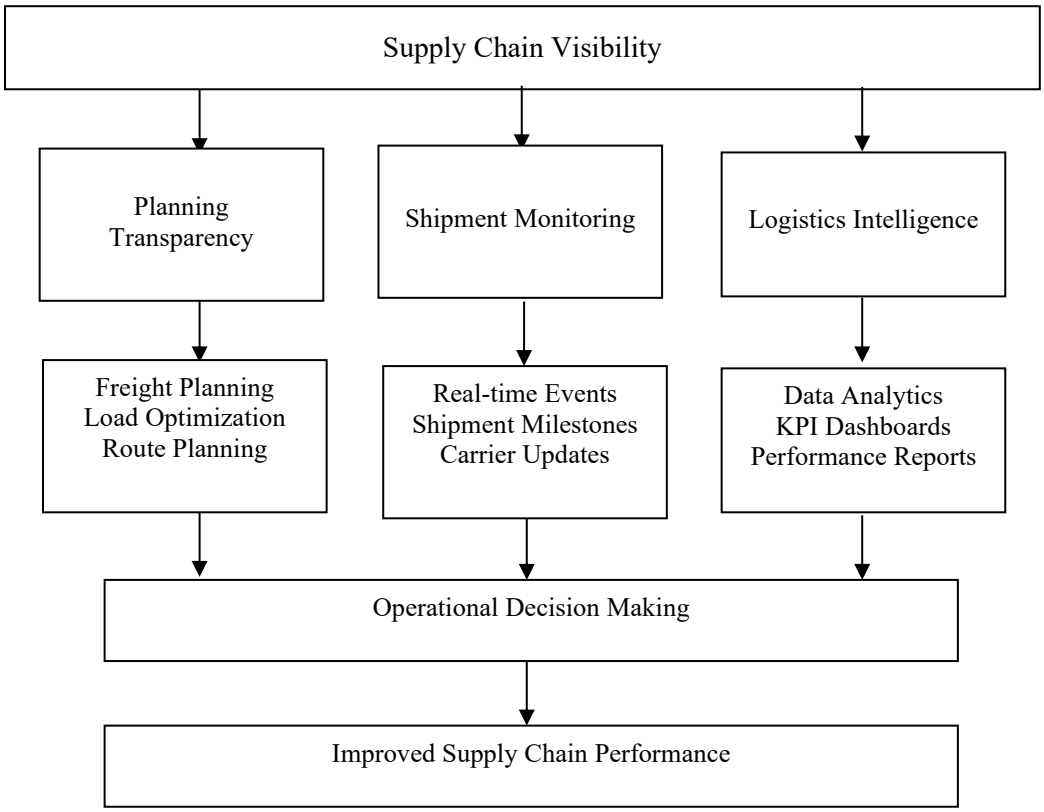

Fig. 2 The Logistics Visibility Maturity (LVM) Framework: four-level progression across Planning Transparency, Execution Monitoring, and Analytics Utilization.

4.2. Dimension 1: Planning Transparency (P)

Planning transparency is how standardized, data-driven, and easy-to-access transportation planning processes are across all parts of an organization. It is the dimension that most directly affects how much an organization knows about its freight before it moves.

Level 1 (Fragmented) means that freight planning is done by hand or with separate spreadsheet-based tools, and there is little or no connection between planning data and enterprise resource systems. This happens more often than you might think, even in big companies. It happens a lot in areas or business units that were not part of an earlier TMS rollout, or that grew through acquisition and kept old processes.

At Level 2 (Emerging), a TMS has been deployed, but adoption is inconsistent. Planners use the system for some functions while continuing to manage others outside it. System-generated plans are frequently overridden without documentation, and master data quality is variable -meaning that the system's optimization outputs are only as reliable as the routing guides, carrier contracts, and transit time data that have been entered into it.

At Level 3 (Integrated), freight order management is fully integrated with ERP systems. This lets demand signals be automatically turned into transportation needs. The TMS keeps track of planning constraints in an organized way, defines and follows exception management processes, and the organization really trusts the plans made by the system.

At Level 4 (Predictive), organizations use scenario planning and dynamic optimization that takes into account changes in fuel costs, carrier capacity, and demand forecast updates. Feedback loops that connect execution performance data back to planning parameter updates are always improving planning processes. This closes the loop in a way that Level 3 organizations want to do but have not yet made it a standard practice.

4.3. Dimension 2: Execution Monitoring (E)

Customers can see execution monitoring the most, and they can feel it right away when it goes wrong. It includes the ability to keep track of the status of shipments and find operational problems throughout the transportation lifecycle, not just at the start and end points.

At Level 1, tracking shipments is only done when something goes wrong. Logistics teams find out about problems when someone else tells them, usually a customer, a plant scheduler, or a carrier, after the fact. The carrier's system has the information, but the organization does not have a reliable way to find it on its own.

At Level 2, basic carrier data connections give you updates on important events like pickup confirmation and delivery. This is a big step in the right direction, but coverage is usually incomplete across the whole carrier base, and alerts do not always get acted on quickly or consistently.

At Level 3, event-driven monitoring works on the main carrier network. The TMS is set up to send automated alerts when shipment milestones do not go as planned, set up escalation processes to send exceptions to the people who need to deal with them, and carrier connectivity covers more than 80% of freight volume by value. At this point, the company is really taking care of freight that is in transit instead of just keeping track of what happened to it.

At Level 4, GPS and telematics integration allows for real-time positional visibility instead of just milestone-based monitoring. Predictive delay detection finds shipments that are at risk of missing planned milestones before they happen. This is a very different approach.

This dimension's Level 3 and Level 4 are different in that Level 3 means you know something went wrong, and Level 4 means you know it probably will go wrong.

4.4. Dimension 3: Analytics Utilization (A)

Analytics usage is probably the least invested area in companies that have otherwise set up good TMS platforms. Having transportation data and using it to make better choices are not the same thing. A big part of the potential TMS value lost is because of the gap between them.

At Level 1, performance analysis is done on the fly and after the fact. You can get freight data by hand for periodic reports, but there is no set way to keep track of carrier performance, and the reports that come out of it do not usually lead to structured action.

At Level 2, the TMS makes standard KPI reports on things like on-time delivery, freight cost per unit, and carrier utilization on a regular basis. The information is out there, but sharing it does not always lead to decisions. The data shows performance trends, but they are not often linked to root cause analysis or structured improvement.

Level 3 is when analytics are used in a meaningful way in operational workflows. Carrier scorecards are used to plan structured quarterly business reviews. Getting around performance data helps with decisions about buying things and reviews of network designs.

People are given ownership of KPIs, improvement goals are tracked, and the organization expects that performance will be explained and managed instead of just reported.

Organizations at Level 4 use advanced analytics, such as machine-learning-assisted capacity forecasting, dynamic routing optimization that changes based on network conditions in real time, and predictive carrier performance modeling.

At this level, planning systems use analytics outputs directly. Instead of running reports, people now have to interpret model outputs and deal with exceptions that the system cannot handle on its own.

4.5. Maturity Level Summary

Table 1. Logistics Visibility Maturity (LVM) Framework -Dimension and Level Descriptors

Dimension	Level 1: Fragmented	Level 2: Emerging	Level 3: Integrated	Level 4: Predictive
Planning Transparency	Manual and spreadsheet-based; no ERP integration	TMS deployed; inconsistent adoption; master data gaps	Full ERP integration; automated freight order creation; maintained routing guides	Dynamic scenario optimization; demand-linked planning with continuous feedback
Execution Monitoring	Reactive inquiry; no proactive tracking	Milestone tracking for primary carriers; no alerting	Event-driven alerts; 80%+ carrier connectivity; defined escalation processes	Real-time GPS/telematics; predictive delay detection; proactive intervention
Analytics Utilization	Ad hoc retrospective reporting; no carrier performance management	Scheduled KPI reports are distributed but rarely actioned	Carrier scorecards; analytics-driven procurement and network decisions	ML-assisted forecasting; dynamic optimization; system-consumed analytics
Typical Visibility Outcome	Highly reactive; frequent surprises; limited response window	Partial awareness; data quality limits reliability	Proactive monitoring; consistent performance management	Predictive management; systemic resilience; strategic optimization

5. Results and Discussion

5.1. Why the Level 2 Plateau Is the Central Problem

The most important finding from the literature synthesis is also the one that matches what practitioners have seen: the move from Level 2 to Level 3 is both the most important and the hardest step in the LVM framework.

Companies that have reached Level 2 have used technology to digitize their transportation processes in a basic way. They have not built the organizational infrastructure yet, like data governance, process ownership, and cross-functional coordination, that is needed to use that technology to its full potential.

This is what I would call the problem of the plateau. There is no clear sign that organizations at Level 2 are failing. Shipments are on the move. Reports are made. The TMS is working. However, there can be a big difference between what the system is set up to do and what the organization is actually doing with it.

The system connects carriers, but their data is not always reliable. Alerts go off, but people do not always do what they say. Planners make plans, but they often do not trust the system's outputs enough to follow them. The technology is here, but the organizational habits that would make it work are not yet in place.

Gunasekaran and Ngai [10] assert that organizational change capacity is the principal factor influencing the realization of information system value within supply chain contexts, aligning with this observation. Industry advisory research empirically corroborates this: organizations exhibiting superior process maturity surpass those with inferior maturity by margins that cannot be solely attributed to platform disparities [6], [16].

The implication for the implementation strategy is straightforward. When moving from Level 2 to Level 3, companies should see it as a separate and planned phase. Their journey to adopting TMS requires them to spend money on change management, data governance, and process standardization that is at least equal to the money they spend on the technology itself.

5.2. Performance Implications of Maturity Progression

The literature reviewed in this study demonstrates that advancement through LVM levels correlates with quantifiable enhancements in transportation performance. Table 2 shows the ranges that were reported in different implementation studies and practitioner reports. These numbers are not set in stone; the actual results will depend on the baseline maturity, implementation quality, and organizational context. However, they do show the performance profile for each transition.

Table 2. Indicative Transportation Performance Improvements by LVM Maturity Transition (synthesized from [1], [6], [7], [16], [5])

Performance Indicator	Level 1 to Level 2	Level 2 to Level 3	Level 3 to Level 4
Transportation Cost Reduction	2% – 5%	6% – 10%	Additional 3% – 5%
Freight Planning Efficiency	10% – 20% reduction in manual effort	25% – 40% further reduction	Sustained through automation

Shipment Visibility Coverage	Partial milestone tracking	80%+ carrier connectivity; alerting active	Real-time positional visibility
Carrier Utilization	Minimal improvement	8% – 12% improvement	Additional 4% – 6%
On-Time Delivery Performance	Marginal improvement	8% – 15% improvement	Additional 4% – 8%
Disruption Response Time	Reactive -hours to days	Alert-driven -minutes to hours	Predictive -pre-event intervention

Take a moment to look at the pattern in Table 2. Performance improvements are not evenly spread out across maturity transitions. The transition from Level 1 to Level 2 does not make a big difference because it gives the organization data that it is not ready to act on yet. The biggest gains usually happen when moving from Level 2 to Level 3.

This is when the organization's ability to use technology catches up with the technology's ability to work as intended. The move from Level 3 to Level 4 adds even more value by making predictions, but only on a base that is already doing well.

This pattern has real-world effects on how companies set ROI goals for TMS implementations. Most of the time, organizations that measure TMS value at the point of go-live, before the organizational development work of Level 2 to Level 3 transition is finished, will be disappointed with the results. Companies that work to reach Level 3 maturity will see much better results, and those that keep working toward Level 4 will see even more improvements.

5.3. SAP TM as a Visibility Platform Across Maturity Levels

SAP Transportation Management has technical features that fit with each level of the LVM framework. The platform's freight order management and carrier integration modules at Levels 1 and 2 provide the basic data infrastructure needed to build visibility. At Level 3, the event management framework—configurable milestone tracking, automated alerting, and exception workflow management—supports the operational visibility features that are part of integrated maturity. At Level 4, the ability to connect to SAP Analytics Cloud and use machine learning within S/4HANA supports the predictive analytics profile of advanced maturity [5], [11].

The main thing to remember is that SAP TM sets a limit on what can be done, and the level of maturity of the organization decides how much of that limit is reached. An organization at Level 2 using SAP TM will see a lot less value in visibility than an organization at Level 3 using the same platform. This is not a criticism of the platform; it is something that all enterprise systems have. It is also why technology selection criteria, while important, are secondary to organizational readiness assessment when deciding whether or not to adopt TMS.

5.4. Applying the LVM Framework in Practice

The LVM framework is meant to be used three times during the lifecycle of a TMS implementation. Before implementation, it helps businesses find maturity gaps that need to be fixed before or at the same time as system deployment. This lowers the chances of getting stuck at Level 2. During the middle of the implementation, it acts as a checkpoint to make sure that the organization's development activities are moving at the same speed as the technical deployment. After implementation, it sets a baseline for performance and helps create structured plans for making things better.

The diagnostic process includes a structured evaluation of current-state indicators across each LVM dimension. This is done through stakeholder interviews, reviews of process documentation, and audits of system configuration. The maturity profile that comes out of this is a dimension-level position map instead of a single score. It shows the specific gaps that are most likely to have the biggest effect on visibility outcomes and helps prioritize improvement projects based on that.

It is important to be clear about what the LVM framework does not do. It does not tell a business which TMS platform to choose. It does not say how fast maturity should happen. Moreover, it does not take the place of the hard work that maturity progression really needs, like managing change, governing data, and improving processes. It gives you a common language and a structured way to diagnose problems, both of which are very helpful in the complicated, multi-stakeholder conversations that come with TMS implementations.

6. Conclusion

The main point of this paper is that supply chain visibility is an organizational success, not a technological one. Platforms like SAP TM are making transportation transparency easier and easier. However, the organizations that get the most out of that infrastructure are not always the ones that chose the most advanced platform. Instead, they are the ones who put money into the process discipline, data governance, and analytical skills needed to use what they have.

The Logistics Visibility Maturity framework put forth here is an effort to make that argument more concrete. The

LVM framework helps logistics companies figure out where they really stand, not where their TMS vendor's sales materials say they should be. It does this by looking at transportation visibility across three dimensions and four levels. It also helps them figure out which development priorities will have the biggest effect on visibility outcomes.

The framework enhances the supply chain visibility literature in two significant ways. In theory, it broadens the visibility construct beyond information systems capability to include the organizational factors that affect how well resources are used. It does this by adding organizational maturity as a primary variable next to technology capability. In practice, it provides a diagnostic tool that logistics organizations and implementation practitioners can utilize in actual operational settings.

The foremost priority for forthcoming research is the empirical validation of the framework. Survey-based studies investigating the correlation between LVM maturity levels and supply chain performance outcomes across various industry contexts would evaluate the framework's predictive validity and enhance its indicators. Research utilizing case studies to analyze the organizational interventions linked to effective maturity progression—especially the difficult transition from Levels 2 to 3—would enhance comprehension of the practical mechanisms underlying maturity development. The creation of a validated LVM assessment tool would facilitate practical implementation.

For professionals, the most important thing to remember is probably the simplest: if your company has bought a TMS and is not seeing the visibility improvements you expected, it is more likely that the problem is with your processes, your data, or your company's habits than with the software itself. This framework is a good place to start when trying to figure out exactly where the gap is.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

Funding Statement

This research received no external funding.

Acknowledgments

The author acknowledges the supply chain management research community whose work formed the foundation of the literature synthesis presented here, and the logistics practitioners whose operational experiences continue to surface the questions that academic frameworks need to answer.

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