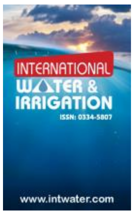

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Current Status and Progress of Supply Chain Model and Its Optimization Research

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Abstract: A multi-objective linear programming (MOLP) model is suggested as a way to build a long-lasting supply chain in today's competitive world. With this, using the particle swarm optimisation (PSO) way to buy things will be cheaper, and buyers and sellers will be able to build lasting relationships. People who want to buy pick one or more sellers and place an order for the right number of goods. This first study looks at the main standards for things like cost, shipping, and delay. It used data from a well-known fuzzy inference system but was still able to solve problems with making decisions based on more than one factor. For example, it could figure out how much something cost, how many things were broken, and how many days the delivery was late. Pioneer Cars gave us some information that we used to make sure the results were correct. With the MOLP cost-optimization model by PSO, it was 3.11 percent cheaper to buy things.

Keyword: Supportive theories, Economic analysis model, Optimization of SCLM.

1. Introduction

Today there are not as many tools as before. The world is getting worse. Factory use makes weather changes happen all over the world because they use a lot of energy and materials. This part of Pakistan's business makes and spends a lot of money. What Sheng et al. (2023) call "green innovation" is the process of making new hardware or software that helps eco-friendly products and processes work better. In the case of green innovation, making things use less energy, trash less, recycle more, and take better care of the world at work is an example of green innovation. People who work together to make something must trade private and personal data with each other. This is important for supply chain management because it makes links last longer and work better (4, 2).

Ashamali (2019) has written a new study that also looks at how GSCM is changing and what issues it will have in the future. A lot of research in this area has also looked at the problems that make it hard for businesses and rich countries to use GSCM (Yu et al., 2021). This new study on GSCM has been done in China, Vietnam, Uganda, Europe, and the US, among other places. South Asia, on the other hand, doesn't have as many studies that look at the situation there. The last study showed that GSCM is often used to help a business do better in the area of the climate and be more competitive. We don't know a lot about how share information and new IT tools affect GSCM and business progress in the field. More research is needed to find out how sharing information, green innovation, and IT innovation affect GSCM methods and what drives people to do better. It will take more work to find out what the business world thinks about GSCM, green innovation, sharing information, and IT innovation.

The study's purpose was to look into how GSCM changes the work that production companies do. Also, the study looked at how GI, IS, and ITI change the link between GSCM methods and how well companies that make things do.

Reading about how green innovation, sharing information, and IT innovation help keep things in order and add to what has already been written can help us learn more and give us new ideas and information. Next, companies that make things might want to look into the study gap. Firms might use more eco-friendly supply chain methods if they understand how GSCM methods affect work better. This might be good for business and the world as a whole.

2. Literature Review

The planning of supply chain tasks is an example of a green method that was used to get more done at work. This made things more efficient and better for the earth in the long run. Gao et al. (2022) say that green supply chain tools check to see how eco-friendly the tech company is. Their study shows that planning a green supply chain and doing other green things are good for the long term, especially when it comes to money, people, and the environment. Studies have found that GSCP tasks make businesses run more smoothly. The 2017 study by Luthra et al. was mostly about how GSCP can help business partners work together and talk to each other better. The study by Chen et al. (2022) looked at how the GSCP changed how factories followed the rules and dealt with risks.

People who do this sometimes call it "green" or "environmental" shopping. What does it mean to think about the world when you buy something? Some people have ideas that are more about getting things. This is done to improve the supply chain. "Green supply" may help their company do its social duty better, protect its image, cut down on waste, and make it easier to follow new environmental laws when it comes to managing its supply chain. "Green et al. (2012)" looked at how buying green products affected the growth of Chinese companies that make things and found that these practices helped the companies. Green Procurement (GP) methods have been shown to help the company that makes gadgets work better in many studies. Klassen and Vereecke (2012) say that GP changed how contractors in the electronics business came up with new ideas and worked together. The study was mostly about how GP helps the business that makes electronics deal with risk and be stronger (Luthra et al., 2015). The study says that GP practices that are good for businesses include choosing sources based on how well they take care of the earth and what activities they do to be sustainable.

There needs to be a green supply chain in the production process so that customers and suppliers can see how the company treats the earth. In the long run, this will hurt the company's growth (Zhou et al., 2023) and make teams from different companies more likely to work together. According to their research, green supply chain execution (GSCE) methods like reducing trash and energy use are good for business since they make things better, save money, and shorten wait times. There is a lot of evidence that the GSCE methods help people do better in business.

If you want to run a green supply chain, you should do the right thing. He says that more businesses are thinking about how to make green policies work with their short- and long-term plans. A lot of programmes have been made to get businesses to act in ways that are better for the environment. Groups are doing more and more things that aren't required by law to protect the environment, on top of the programmes that are. People talked about the rules for setting up a reverse distribution network and how to do it. Additionally, some have said that companies desiring to collaborate on green initiatives must possess certain expertise. We examined how companies in the industrial and technology sectors use green supply chain management. They argued it was critical to take actions that benefit the environment, such as creating environmentally friendly designs, packaging, and goods. Luthra and colleagues examined the factors that influence the use of green supply chain strategies in the electronics industry. They discovered a number of obstacles that hinder the adoption of green practices in the supply chain, including environmental regulations, stakeholder pressure, and customer feedback.
GSCM can be judged in different ways based on how it is measured, how many people use it, and how quickly it is growing. Going green with their supply line could help them save money. Also, suppliers could have a say in what is chosen, which might lead to eco-friendly new ideas. Company often buys eco-friendly goods from other countries and starts eco-friendly programmes that impact the whole business. Research shows that companies do not believe it is their duty to care for the earth. It wasn't made clear enough what the laws and rules are that protect

the earth and why it's right to do things that are better for it. The things we have, the way we learn, and the way we think would cost too much to change.

2.1 Supportive Theories

The Resource-Based View (RBV) idea says that a company should carefully use its skills and resources to get ahead of the competition. To do this, resource and skill study is used to find out what the organisation does well and what it could do better. GSCM has more resources available because eco-friendly methods and new ideas were used in this case study. In turn, this leads to better work and success in the industry field. This theory tries to explain how new tools or ideas get passed around a group of people. It gives you important details about how businesses and other places use green ideas and IT tools. People must first understand and agree with this theory in order to use and share these kinds of new ideas in GSCM and the supply chain. Transaction cost economics (TCE) is the study of how transactions, both within and outside of government, may alter the way that things are managed. They are aware of how critical it is to collaborate and exchange knowledge. This research examines new technologies and information sharing and how they affect the relationship between cost savings and green supply chain practices. As a result, green supply chain techniques have improved and become more beneficial.

The Social Exchange Theory says that friends and family should be fair and look at both the pros and cons of each other. This fits with the study's look at how partners in the supply chain can share data to help people work together and learn from each other. This shows that green ideas can make businesses run better and give them an edge over their competitors. Resource Dependence Theory says that for businesses to stay in business and do well, they need to keep good relationships with the people who provide them with resources. It helps us figure out how GSCM changes when new green and IT ideas are added as part of this study. The video also shows how companies that make things try to use less nonrenewable resources and deal with the legal risks that come with that. It also looks at how groups deal with problems and stresses that come from outside their walls.

Researchers used assumptions from the study and a review of the literature to make the theory framework in Figure 1.

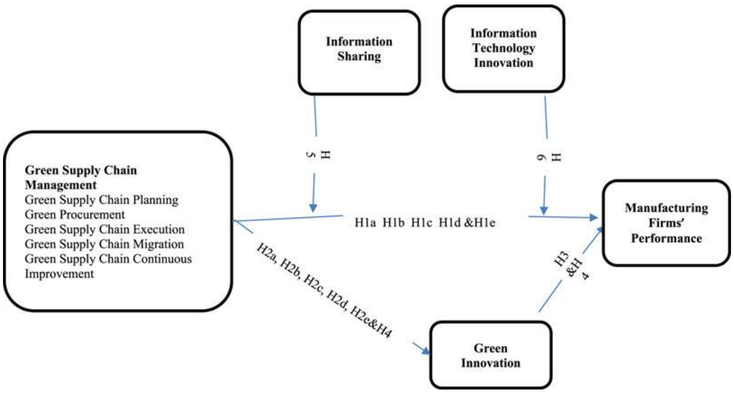


Figure 1: Proposed Theoretical Framework.

3. Economic Analysis Model of The Iot-Based Sclm

People who work in the SCLM of ITE and other experts who have done work in similar areas are both looked at in this section. It's clear that people are talking about IoT technology. Case studies are another way to check how well the plan model works.

3.1 IoT-based SCLM system

It is better for people to use because it has a smart IoT-based SCLM system that knows how ITE works and how to handle it. Figure 1 shows A smart mechanical control module lets you see what's going on around the logistics truck at all times. The production centre always knows where the car is and what's close because it talks to the main business computer. Setting things up in the right places can be done with the set terminal interface, the mobile terminal, and the smart system. You can also use it to find things, set them away, and sort them. It can also find organising staff and send that data to the main computer so that personal information can be uploaded and customer information can be ordered. This means that there are smart and well-thought-out ways to move and store data. The business records office then gets the news about the people and the goods. It can then make success data by putting together the name data, the product data, and the work data. In short, this is what smart transportation data is all about.

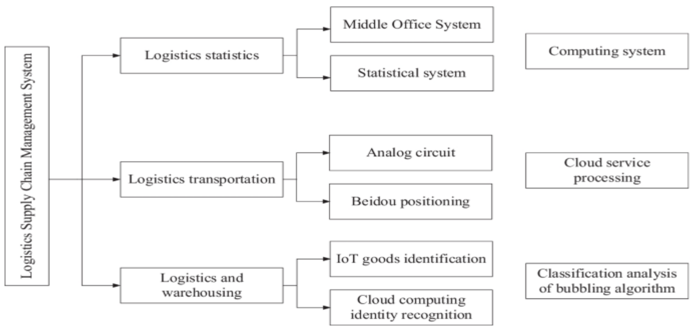


Figure 2: Iot-Based SCLM System

The IoT-based smart SCLM system has two parts that change whenever the business does something. Figure 3 shows a smart method for delivering goods by transport. This is the beginning. The second part is shown in Figure 4. This is the smart way to store and send things. Part 1 is mostly about how positioning technology and real gadgets can be used in smart cars to move things. The technical module's job is to watch what the main server does and what data is being sent at the moment.

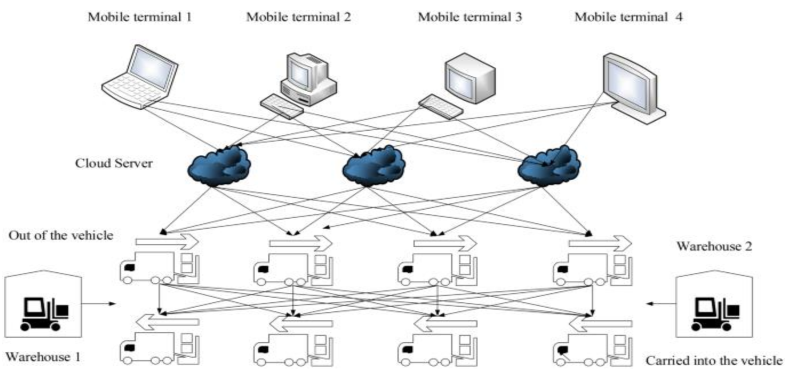


Figure 3: The Main Parts of The Train and Bus System for Running

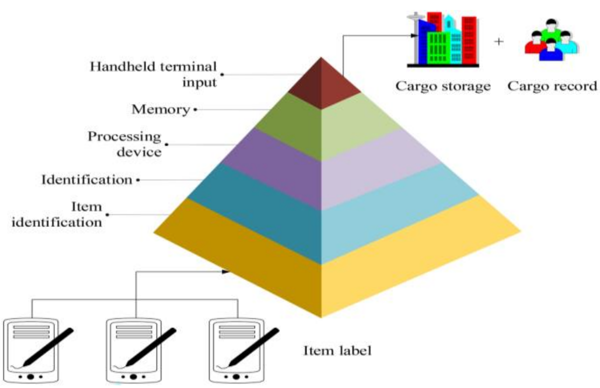


Figure 4: The Main Parts of The Transportation and Storage System

Figure 4 shows the main parts of moving and storing things. There are stickers that can read IoT devices, technologies for automatic sorting, labelling, and placing, and a system for sorting staff identification. It shares information about storage and movement as events happen in real time. This data is then looked at by statistics on the main machine.

The Internet of Things is used to build the smart SCLM system. Technologies like RFID, analogue control, and programme designs are used. The smart SCLM system can do many things and can be used to move people instead of the ITE's tools. Smart travel is being built for ITE while they go shopping.

3.2 Optimization of SCLM for ITE

The SCLM method we have now doesn't work well with transportation or understand what's going on with it right now. The analogue circuit and the location-based data transfer units are the two major parts of the smart IoT-based SCLM system. In this case, we can say that the smart SCLM system based on IoT is better for transportation. It has screens, smart delivery cars, gadgets that send and receive data, and computers and storage in the cloud. The device that sends data and the device that tracks temperature are linked. The gadget may transmit control messages and position data over this connection. A network connects the cloud service engine with the data sensor. They can now transmit and receive location data and control signals thanks to this. It is connected to at least one cloud service processor or data collecting device in order to store tracking data and manage signal transmission. The display gadget can get tracking information, control messages, and show them. Where is the smart transportation truck at all times? The tracking centre has a screen that can do that. The right shape is shown in Figure 5. The way that moving cars work sends data to the main data centre in real time. The main data centre then sends all the tracking signs and data back to the main office so that the production design can begin (Fig. 6). The production design office then controls and adjusts the cars that move people and things around the SC to keep the whole thing together.

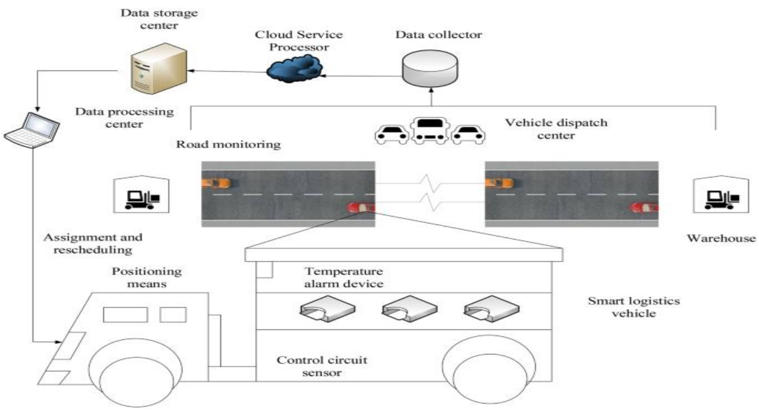


Figure 5: Making It Easier for ITE Customers to Get Services

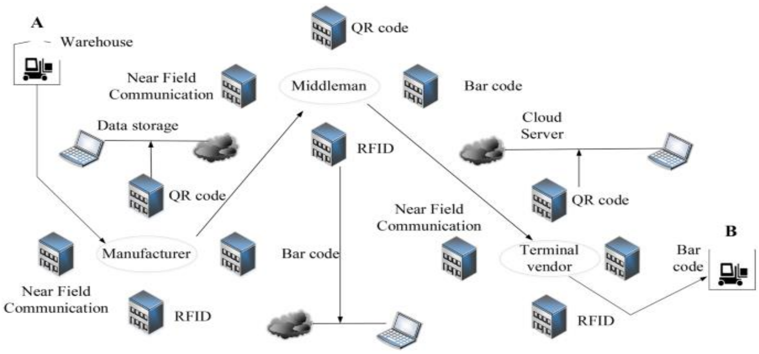
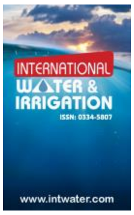


Figure 6: One Way That ITE Could Improve Its Processes and The Way It Manages Its Stock Supplies.



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The SCLM system plan, which is smart and IoT-based, classifies everything that stores data as an IT good. The IT objects may be equipped with an RFID tag, barcode, QR code, NFC tag, or a combination of these. There are several ways to identify IDs, such as barcodes, NFC tags, RFID tags, and QR codes. This can be written on an IT item. The boss can check the bound data to see who is responsible for putting away lost or broken things. It's now simple to see who is in charge of what in management.

3.3 Equipment Parameters and Performance Analysis

Equipment parameters:

You can find the transportation truck by putting a GPS unit in the cab of it. You can use the GPS+Beidou dual tracking gadget to help. This item has the style number ATK1218-BD ATK-S1216. The study took place in the parking lot of a big ITE. It's possible to load and unload at the park, where There are two lines and four train gantry cranes. The center box has seven lines total. The transmitting box area has 1-4 lines, whereas the receiving box area has 5-7 lines. The main box room can accommodate two stacks of boxes. Table 1 shows the rules for the place where cars can put and take off goods.

You can learn how the train gantry crane works by reading books and other materials that are connected. This is important for the case study. However, given the pace of technological advancement, the outcomes may differ in practice from those that were selected. For this reason, they will only be used in this case study. Table 2 displays the components of the train gantry crane.

Table 1: Parts Of the Place Where Containers Are Loaded and Emptied

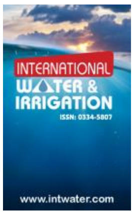
Functional areas	X coordinate value
Train loading and unloading line	1,2
Sending box area	3,4,5,6
Arrival box area	7,8,9
Truck operation channel	10

Table 2: How To Use a Train Gantry Crane

Related parameter names	Parameter values
The average speed of the cart	90 m/min
The average speed of the car	90 m/min
Average time of up and down of the heavy box	45 s
Average no-load up and downtime	30 s
Alignment locking time	15 s
Alignment release time	10 s
Safe working distance	7 m

Empirical Analysis:

Based on the work that needs to be done, it should take three hours to move 132 cases from one place to another. At the start of time, a train with 60 containers pulls onto the queue to make room for more. At the same time, a train with room for 60 containers pulls up and starts to load. 16 cars got there on time to load and unload, so work can now begin. This improves the game in two ways: not important and important. First, we look at the prices of the Average Queue Time of cars (AQT), the Average Queue Length (AQL), and the Average Length of Stay (ALS) to see which mode gives you the best value for a certain amount of time spent waiting, the number of great gas stations, and the AQT, AQL, and ALS. When necessities and wants are closely balanced, the better line style is chosen for those areas. Secondly, until the optimal method of waiting is determined, no decision is made to ship. The effects of the different objectives are then compared for the ALS, AQT, and AQL. Next, the AQT modifications of traffic-agnostic autos are also examined. Finally, a model of the operation of the gate area of the



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industrial park is made using the AnyLogic planning tool. You've got thirty days to lose weight. It immediately provides the AQL, AWL, and ALS upon the conclusion of practice.

4. SCLM Performance Analysis

This part mostly looks at the suggested economic analysis model of IoT-based SCLM from four different points of view and rates how well it works. It does this by checking how well the non-priority model and the priority model work, as well as the advantages and uses of SCLM economic planning. Tests that compare models then show that the model that was suggested works better.

4.1 Non-Priority Model Performance Comparison

The best places to get assistance for AQT, AQL, and ALS are shown in Table 3. It turns out that the best rest stops become less useful as the wait time goes up. The best server units stay at 9 when a single model needs less than 20 minutes of time. When the time limit of the fusion model is reached, the best server units shut down. The AQT of the single model is lower than the AQT of the fusion model when just one service station is utilized. In comparison to the single model, the fusion model has a much lower AQL and requires around 25 minutes less to wait. The mix model operates more slowly than the single model. This is a less expensive option to run and move about in the park.

Table 3: Different Kinds of Wait Times and Time Limits for Truck Lines

	Number of service stations (sets)		AQT (min)		AQL		ALS (min)	
Waiting time threshold (min)	Single queue	Multi-queue	Single queue	Multi-queue	Single queue	Multi-queue	Single queue	Multi-queue
5	9	10	2.58	4.77	4.89	0.57	7.79	9.97
10	9	9	2.58	6.96	4.89	1.01	7.83	12.16
15	9	9	2.58	6.96	4.89	1.12	7.64	12.28
20	9	9	2.58	6.96	4.89	1.24	7.86	12.38
25	8	9	21.26	6.89	32.96	1.35	26.45	12.47
30	8	9	21.26	6.79	32.96	1.56	26.63	12.15

Table 4 shows how many service stations are in the gate area based on the usual service rate, the number of cars coming in, and the AWT level. When the AWT level is low and the average service rate is high, it's easy to tell the two types apart. It's also easy to tell the difference between the two types when the AWT limit and the average service rate are both low. It does take up more space, though, and the wait time is much longer. A goal for a single model needs to be set so that getting things planned and delivered goes quickly and easily.

Table 4: Number Of Petrol Shops in The Gate Area Changes Over Time.

Service rate (vehicles/min)	5-single queue	5-multi-queue	10-single queue	10-multi-queue	15-single queue	15-multi-queue	20-single queue	20-multi-queue	25-single queue	25-multi-queue	30-single queue	30-multi-queue
0.14	12	16	12	12	12	12	12	12	12	12	12	12
0.145	12	16	11	12	11	11	11	11	11	11	11	11
0.15	11	15	11	12	11	11	11	11	11	11	11	11
0.155	11	13	10	11	10	11	11	11	10	10	10	11
0.16	10	13	10	11	10	11	10	11	10	10	10	10

4.2 Priority Model Performance Comparison

You can see how the jobs in Scenes 1–3 with different goals stack up by looking at Table 5. The AQT and AQL don't change much when the priority level 1 ratio changes (about 0.1 min). But when the priority level 4 split changes a little, both of them change a lot (for about 10 minutes). As the importance level goes up, the numbers change less, but the ratio change stays the same. For the business to decide which supply level is the most important, it should look at how much each level costs in goods.

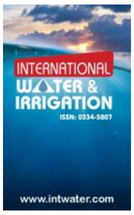

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Table 5: A Look at How Different Amounts of Goals Change How the Gate Area Works

	scene 1			scene 2			scene 3		
Percentage of different priorities	AQT (min)	AQL (vehicle)	ALS (min)	AQT (min)	AQL (vehicle)	ALS (min)	AQT (min)	AQL (vehicle)	ALS (min)
Scenario 1-Level 1	0.681	1.097	5.964	0.647	1.094	5.808	0.698	1.154	5.928
Scenario 1-Level 2	0.953	1.275	6.085	0.972	1.363	6.152	1.165	1.447	6.363
Scenario 1-Level 3	2.386	2.27	7.601	2.705	2.39	7.94	3.178	2.443	8.413
Scenario 1-Level 4	56.684	30.72	61.876	65.923	30.91	71.082	68.868	31.878	74.061

Table 6 shows that there are different amounts of IoT priority and IoT-based service stations. The model works very well. Things that don't use IoT seem to have longer AWTs than the first three things that do. Longer the AWT is, the more important the level. The average working temperature (AWT) of IoT-based automobiles is 34 times lower than that of non-IoT-based cars after 8 gas stops. There are fewer gas stations along the AWT, and the planned transportation operates more efficiently. This suggests that the SCLM approach based on IoT may improve service and guarantee that things happen on schedule.

Table 6: Comparisons And Analyses of The Effectiveness of The Model

	Number of service stations = 8			Number of service stations = 9		
Different optimal work methods	Priority 1	Priority 2	Priority 3	Priority 1	Priority 2	Priority 3
8-No IoT-Level 1	21.265	21.265	21.265	2.586	2.568	2.586
8-IoT-Level 1	0.681	0.647	0.698	0.375	0.381	0.387
8-IoT-Level 2	0.953	0.972	1.165	0.521	0.546	0.614
8-IoT-Level 3	2.386	2.705	3.178	1.107	1.287	1.344
8-IoT-Level 4	56.684	65.923	68.868	5.693	6.778	6.801

4.3 SC Economic Optimization Results

In Table 7, you can see a comparison of the different ways to improve work. It was found that the AQT of the fusion model is 2.7 times higher than that of the single model when IoT structure is not taken into account. Since the addition of the IoT framework, the model's AQT, AQL, and maximum wait time have been significantly decreased. The AQT of automobiles with level 1 priority may be reduced by almost seven times using IoT-based techniques. Therefore, the Internet of Things (IoT)-based approach is superior, and priority intelligent automobiles may reduce the time required to transfer products and improve the efficiency of transportation.

Table 7: The Findings of Comparing and Researching Various Approaches to Improving Jobs

Percentage of different priorities	AQT (min)	AQL	AQL (vehicle)
No IoT-Single	2.587	4.88	41
No IoT-Multi	6.699	1.03	5
IoT-Level 1	0.371	1.05	4
IoT-Level 2	0.514	1.15	6
IoT-Level 3	0.969	1.44	11
IoT-Level 4	5.366	4.15	37

The goal functions of the different approaches are displayed in Table 8, along with a graph that illustrates their convergence over time. The findings indicate that the proposed IoT programme can be completed more quickly. The results of the two algorithms' computations are comparable. Nonetheless, this study is the first to examine the algorithm's structure from the SC's perspective. In the past, researchers have only examined it from the perspective of one particular transportation system. The study's findings can be used to ensure that ITE's SCLM functions properly.

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Table 8: An Illustration of The Objective Function's Temporal Convergence for Several Scenarios

Number of iterations	Objective function value	Objective function value
7.255301	128.4808	128.6542
12.72578	127.6387	127.9855
18.10702	125.0975	122.9394
28.93196	121.2044	120.9239
49.93932	118.6844	118.5707

4.4 Supply Chain Optimization Application Analysis

Table 9 shows the filling and dumping steps in a number of different ways. It was found that processes that load and unload on different paths have a 5.8 difference and a 0.5 difference, respectively. This means that most of the steps for each track are the same. Path 4 is the only one where the empty moving ratio changes a lot. It's hard to tell them apart because of this. This shows that the proposed model works well with operations in various SC and makes loading and lifting faster while keeping the general movement the same.

Table 9: Methods For Filling and Emptying

Door crane serial number	Total operation time (min)	Total idle time (min)	The proportion of empty driving (%)
1	98.15	4.56	4.44
2	104.93	4.08	3.74
3	101.43	4.4	4.16
4	101.96	5.87	5.44

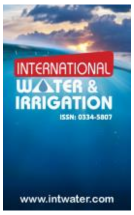
Table 10 shows the numbers that were used to rank the different job paths. It tells you how long each task method will take to finish. As you can see, it takes less time to fill and empty when the number is bigger. Improving the way IoT-based containers are loaded and unloaded can make certain chores faster and better, boost the number of on-time supplies, and make business service better overall.
In Table 10, you can see how long car delays lasted before and after the Internet of Things was put in place. According to the findings, completing ITE tasks required an extra 107 minutes both before and after IoT adoption. On the other hand, AWT jobs using IoT need almost four times as much time to complete. The process of adding and removing items is accelerated by the Internet of Things (IoT). Additionally, it always tells you where the tools and boxes are. This demonstrates how the park can function more smoothly and reduce the amount of time that automobiles must wait by utilizing the Internet of Things to load and unload trucks.

Table 10: Truck Lateness Intervals Before and After Iot Implementation

Collection card arrival time	Expected completion time	The actual completion time
0.632569	18.49686	12.23226
1.381564	23.83789	17.5733
2.190528	29.80674	24.79366
3.208527	34.52641	30.13938
4.34748	44.57483	46.14258

5. Discussion And Conclusion

A new SCLM approach based on the Internet of Things (IoT) is suggested to facilitate the migration and ongoing optimisation of ITE. The proposed solution consists of three components: smart storage, smart transportation, and smart computing. Inter-monitor communication is a feature of smart transportation. The big data analysis technique may be used to develop the central transport plan analysis method. A new version of the smart storage single point-to-point tracking technology has been released. Everything in the SC is secure because each link has been carefully crafted to work as intended. Large volumes of data are processed for the first time in smart computing. The AWT of transport cars decreases with improved smart shops and travel plans. The speed at which



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the park operates generally increases as well as the speed at which trucks are loaded and unloaded. As a guide, the results are quite helpful in changing the SCLM of ITE.

However, there are a few issues with it. The IoT-based computing approach holds the key to improving the efficiency of transportation. This paper examines a few popular algorithms, but it doesn't provide enough details to explain why the algorithms perform better. Second, the performance study of the model compares certain approaches that have only recently been examined. The follow-up work will examine these two areas in further detail in an effort to improve the programme. Additionally, it will acquire additional methods to function better, and the ITE SCLM will be further improved. SCLM may benefit from machine learning (ML) in a number of ways, including risk reduction, resource optimization, customer happiness, and the creation of new business strategies. Deep Learning (DL) is advantageous to SCLM as it can learn numerous things at once. Using Neural Network (NN) or Particle Swarm Optimization (PSO) methods in Deep Learning (DL) may enhance the SCLM system. We'll look more closely at these methods in the next post.

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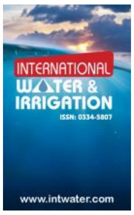

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