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List of Abbreviations

Abbreviation	Meaning
3PL	Third Party Logistics Provider
4PL	Fourth Party Logistics Provider
APS	Advanced Planning System
CMR	Contract for the International Carriage of Goods by Road
CO ₂	Carbon dioxide
CO ₂ e	CO ₂ equivalents
CUG	Closed Users Group
ERP	Enterprise Resource Planning
ETA	Estimated Time of Arrival
GET	Green Europe Transportation
GPS	Global Positioning System
JdR	Jan de Rijk Logistics
LSP	Logistics Service Provider
SaaS	Software as a Service
TMC	Traffic Message Channel
TMS	Transport Management Systems
VRP	Vehicle Routing Problem
WMS	Warehouse Management Systems

Executive Summary

Deliverable 5.1 is prepared to see the whole picture of the state-of-the-art transport planning tools for the Green European Transportation (GET Service) project. Around 49 Transportation Management System (TMS) solutions and four online freight platforms are available in the market. This report used the available professional and academic literature, software vendor websites, etc. to identify these tools, and review their functionalities with regards to several dimensions. The focus on the use of the planning tools in real-life environment is extremely important. The real-life world is dynamic and stochastic and information on this setting should be available via the GET framework as planned.

A transportation management system can be seen as a part of planning and execution system, also a complex system that combines equipment, operations, personnel, communications, and advanced information technology to achieve specific targets. TMS has been a critical emerging area for manufacturers, distributors, and third party logistics providers (3PLs). As the complexities of transportation increase, companies are being challenged to keep their costs low but to improve the speed and reliability of their transportation network. Many of TMSs are tailored for companies to optimize their transportation costs and give required information to respond to daily challenges and opportunities. Based on our findings, the important insights are summarized as follows. These findings are highlighted for the success of the GET Service project.

- ✓ Several groups (users) need TMS and it is therefore important to tailor the software based on the requirements of the user. This is mainly discussed in the **Deliverable 1.2** of the GET Service project.
- ✓ Planning & Optimization, Execution, and Visibility & Performance Management are important components of a standard TMS solutions. These dimensions are already being considered in several work packages.
- ✓ A new trend is offering TMS solutions as a shared software service over the Internet. This change is one of the most important requirements in the TMS market. Even though small companies can benefit more from this feature, larger companies may show an interest in this business model because it can mean less of an upfront investment.
- ✓ Network integration and sustainability are major developments that will continue to shape the market in the close future. At this point, the GET Service project will provide efficient tool to respond to these new developments.

- ✓ Green awareness should be included in transport planning systems. It is therefore very important to measure the carbon dioxide equivalent (CO₂e) emissions accurately. The tools discussed in **Deliverable 1.3** will help to achieve this target.
- ✓ Current TMS software is very focused on the planning and optimization of assets. In a lot of cases, this is completely centred on trucks, but some of the solutions have multimodal capabilities. Mode selection, service network design, capacity management should be processed with transportation management system. These features will be offered as an important difference of the GET Service project.
- ✓ GPS tracking must be installed respectively devices on trucks as complementary equipment for the consistent communication during transportation. The interaction can be processed with the help of the GET Service project solutions.
- ✓ Systematic maintenance schedule of the IT systems is mandatory.
- ✓ The new developments should foster the enhancement of TMS software solutions.

Communication and visibility are the very basic components that enable the multi-player collaboration such as shippers, third party logistics providers (3PLs), carriers, and authorities (e.g., customs). An interesting development like GET can offer a solution over the whole network where many of users can benefit of having such systems. This will potentially minimize the effort and investments needed in setting up communication platform for all users.

1 Introduction

A transportation planning is an application of planning techniques in the operation, provision and management for any modes of transport to achieve safe, faster, comfortable and environmentally suitable movement of freight goods. In order to successfully achieve better planning of freight movements, Transportation Management System (TMS) solutions and online freight platforms have been analysed.

The TMS is a subset of supply chain management concerning transportation operations and can be located in the core of the Logistics Service Provider’s (LSP) operations. The TMS also links Enterprise Resource Planning (ERP) system and Warehouse/distribution Management Systems (WMS).

A typical system includes both inbound (procurement) and outbound (shipping) orders to be evaluated by the TMS while offering the user various suggested routing solutions. These solutions are evaluated by the planner and are passed along to the transportation provider analysis module to select the best mode and least cost service provider. Once the best service provider is selected, the solution typically generates electronic load tendering and track/trace to execute the optimized shipment with the selected carrier, and later to support freight audit and payment [1]. An overview of the outbound supply chain is given in Figure 1.

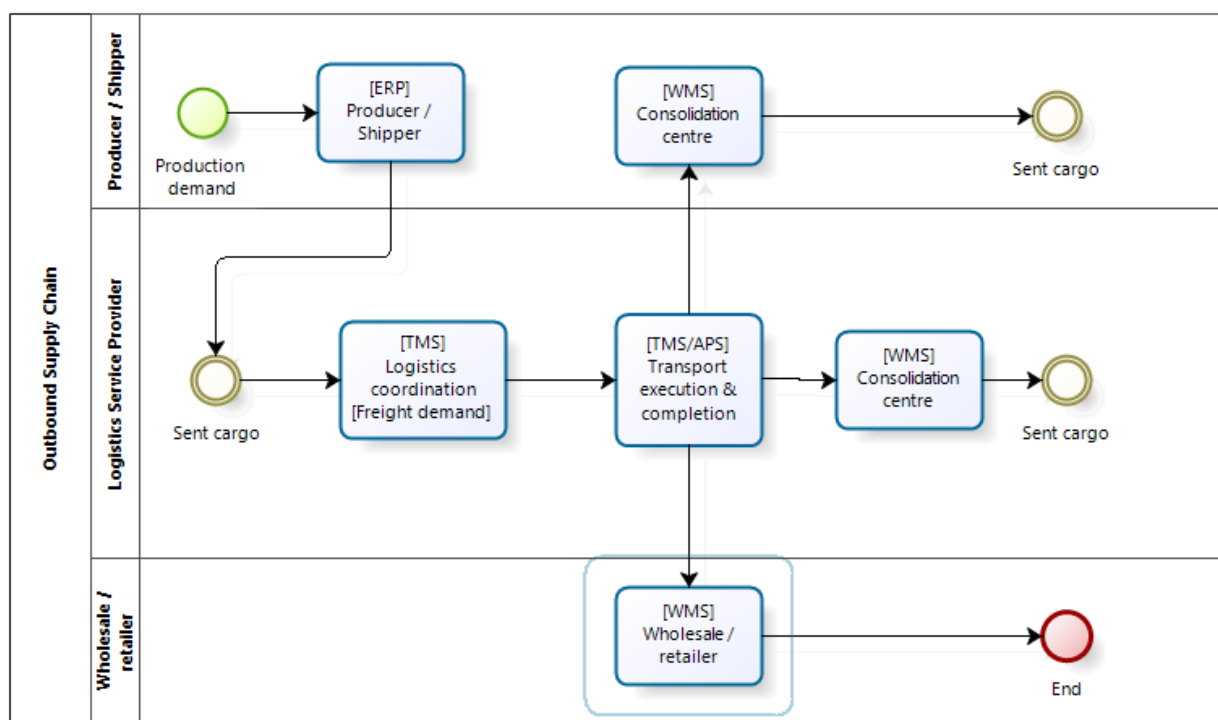


Figure 1: An overview of the outbound supply chain

TMS has been a critical focusing area for manufacturers, distributors and third party logistics providers in their pursuit of developing a lean, agile and efficient customer-oriented supply chain. It has been developed since the second half of the 20th century. In the last decade, companies began to develop TMS's unique multiple functions to manage their operations for the challenging environment. Today's most medium and large companies have purchased and applied transport management to manage and monitor their business.

It is not easy to use defined terminology when discussing TMS software. The same word can mean very different things to different groups. Software companies use words to describe their products in a way that will make them look all encompassing, integrated and state-of-the-art. This makes it difficult for potential buyers to determine what the real functionality is. Our target within this report is to establish some guidelines and collect some insights from these software tools using several data collection methods.

2 Transport Management Systems

A Transportation Management System refers to a category of software that deals with the planning and execution of the transportation of products along supply chain [2].

In general, a TMS system is being used by one LSP for these functionalities:

- **Order handling:** Order entry, order control, order consolidation, order geo-coding, order distance calculation (mostly done via external distance calculator servers like PTV's x-Server-distance) etc.
- **Order completion:** Invoicing
- **Asset management:** Type of asset, amount of km driven, maintenance, damage control
- **Driver management:** Skills, licenses (like European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) for transporting dangerous goods)
- **Planning:** This is often done outside the TMS system with the use of specialized planning software like the software of PTVgroup or Quintiq.
- **Document control:** Like printing CMR documents, T1 and/or T2 documents, all kinds of way bills
- **Customs control:** For exporting goods a LSP has to request a MRN (movement reference number) at the customs; this is done via EDI (although not possible in every EU country).
- **Security control:** This is mostly very specialized and depends per LSP and is often classified information.
- **Reversed logistics:** Keeping track of empty containers / freight units / trolleys / etc., balancing when part of a pool mechanism
- **Charter control:** Keeping list of charters, selecting a charter, pricing, forward order to charter
- **Execution:** At this level the TMS keeps track of the status of the order and the logistics activities. It can integrate information from external sources like a fleet control system a fleet control system is architecture based on telecom networks, truck on-board computer devices and data collection servers.

In a broad classification, various subcomponents/features of a typical TMS can be categorized into three categories, namely *i)* planning and optimization *ii)* execution, *iii)* visibility and performance management. These categories are listed below.

i. Planning and Optimization

The key features that a TMS supports with respect to planning and optimization are:

- Load consolidation
- Route planning and scheduling
- Mode and carrier selection
- Trip/Tour planning and optimization

ii. Execution

The key features that a TMS supports with respect to execution are:

- Freight audit and payment
- Freight procurement
- Multi-modal transportation
- Invoicing and document handling
- Event management

iii. Visibility and Performance Management

The key features which a TMS supports with respect to visibility and performance management are:

- Shipment tracking and trace
- Visibility and event management
- Analytics
- Performance measurement

The list of available Transport Management System software products is listed in **Table 1**.

Table 1: List of available Transport Management Systems

No	Software Package	Company/ Manufacturer	Operating Country(ies)	Website
1	Direct Route [2]	TMW Appian	USA	www.appian.tmwsystems.com
2	INTRIS [3]	Intris NV	Europe	www.intris-group.com
3	Sterling Transportation Management System [4]	IBM	International	www-03.IBM.com
4	Optrak Routing & Scheduling [5]	Optrak Distribution Limited	Europe	www.optrak.co.uk
5	ORTEC Transport and Distribution [6]	ORTEC International	International	www.ortec.com
6	Logistics Planning Solutions [7]	Quintiq	USA, Europe, Asia pacific	www.quintiq.com

7	Trampas [8]	Staedtler Transport Consulting	Europe	www.staedtler-logistik.de
8	Show Trip, Controller [9]	Replica Sisterni	Italy, Turkey	www.replica.it
9	SAP TM [10]	SAP	International	www.sap.com
10	PRA Car 3000 [11]	Wanko	Germany	www.wanko.de
11	Living Systems Adaptive Transportation Networks (LS/ATN) [12]	Whitestein Technologies	International	www.whitestein.com
12	Descartes Delivery Management Suite [13]	Descartes	UK	www.descartes.com
13	4S Shipper Logistics [14]	Four Soft	International	www.four-soft.com
14	Paragon routing [15]	Paragon	International	www.paragonrouting.com
15	Kewill Transport [16]	Kewill	Europe	www.kewill.com
16	WORKsmart [17]	TomTom	International	www.tomtom.com
17	PTV Map & Guide [18]	PTV	International	www.ptvgroup.com
18	PTV Smartour	PTV	International	www.ptvgroup.com
19	Transport Management [19]	Oracle	International	www.oracle.com
20	Roadnet [20]	Roadnet	International	www.roadnet.com
21	COSware [21]	COS	Germany	www.cosonline.de
22	Cargo Online [22]	DBH Logistics IT	Germany	www.cargo-online-software.de
23	CargoSoft SCM [23]	Cargosoft	Germany, Singapore	www.cargosoft.de
24	TMS [24]	GreenCat	Europe (Netherlands)	www.greencat-it.com
25	Netmover [25]	Tesi	Italy, France, Netherlands	www.gruppotesi.com
26	TransWareOne [26]	CSD Logistik Software	Germany	www.csd-managementd.de
27	HighJump Transportation Management [27]	High Jump	International	www.highjump.com
28	L-wiS [28]	Active Logistics	Europe	www.active-logistics.com
29	i2TransportationManager referredasJDA) [29]	i2(JDA)	International	www.i2.com
30	inet TMS [30]	inet-logistics	International	www.inet-logistics.com
31	ASSIST4 [31]	AEB	International	www.aeb.de
32	TMS [32]	DDS Logistics	International	www.ddslogistics.com
33	LeanTMS [33]	Lean Logistics	Europe	www.leanlogistics.com
34	Voyager Transportation Planning & Management [34]	Logility	USA	www.logility.com
35	Transportation Planning & Execution [35]	Manhattan Associates	USA	www.manh.com
36	Cofano logistic suite [36]	Cofano software solutions	Netherlands, Germany, Belgium	www.cofano.nl
37	IXTransport operator [37]	IXolution	Europe	www.ixolution.com
38	C-logistic and C-sped [38]	C-information system	Germany, Austria	www.cis-wurzen.de
39	Komalog [39]	Transdata	Austria, Germany, Switzerland, Luxembourg	www.transdata.net
40	Transworks TMS [40]	TransWorks	USA	www.trnswrks.com
41	TourboRoute [41]	Tourbosoft	Germany,	www.tourbosoft.de

			Switzerland, Austria, Luxembourg	
42	Xcargo [42]	Locom	Europe	www.locom.com
43	Spedipro 5.0i [43]	Spedipro	Germany, Luxembourg	www.spedipro.com
44	FLS visitour [44]	FastLeanSmart	Germany	www.fastleansmart.com
45	InconsoTMS [45]	Inconso	Germany	www.inconso.de
46	CargobaseTMS [46]	Reteco	Germany	www.reteco.de
47	SNC Cargo [47]	Sievers-SNC	Germany	www.sievers-snc.de
48	LBASE 6 [48]	Imtech ICT	Austria	www.imtech.com
49	DisponentPlus [49]	Weber Data Service	Germany, Austria, Switzerland, Netherlands	www.weberdata.de

After identifying various Transport Management System (TMS) software packages, every TMS package with a certain set of common dimensions has been analysed. A total of 10 dimensions were listed based on the requirements. A dimension denotes the performance/ability of a TMS to carry out a certain action (for e.g., ability to plan a route by considering different modes of transportation). The selected dimensions are listed below.

- Vehicle routing and scheduling
- Online/offline planning
- Optimization algorithms
- Multi-objective optimization
- Inter-modal trip planning
- Green logistics
- Congestion/time dependency
- Synchromodal trip planning
- Event handling
- Message processing/integration (telematics)

Once the dimensions were set, the next step was to check how many of the above dimensions were satisfied by each of the TMS. To do this, a survey has been designed that was aimed at collecting response from the owner of each TMS about the capability of their TMS. The survey contained 10 questions with each question associated with a particular dimension. The response to each questions had a possibility to be a binary response (yes or no) or descriptive as well. The survey was then sent to every TMS owner. The open-source software used for the designing of survey was the domain "www.surveymonkey.com". The responses were automatically collected by the website. The survey template can be found in **Appendix A**.

The response rate for these survey questions was however not very good. Very few TMS owners had taken the initiative to answer the survey. Therefore, an analysis has been conducted based on the information provided by the IT provider's website and from scientific literature.

In the next subsections, the performance of each software package in the specific *Dimension* (denoted by sub-section) is being analysed.

2.1 Vehicle Routing and Scheduling

This dimension determines the capability of the software package to perform the basic functionality of performing routing calculations and scheduling activities.

Freight transportation has many facets, particularly when viewed from the multiple levels of decision-making. Arguably the most famous problem at the operational level is the Vehicle Routing Problem (VRP). The VRP consists of designing optimal delivery or collection routes for a set of vehicles from a central depot to a set of geographically scattered customers, subject to various constraints, such as vehicle capacity, route length, time windows, precedence relations between customers etc. The VRP arises naturally as a central problem in the fields of transportation, distribution and logistics as with every increase in a delivery point/node.

However the VRP consists of many different problem dimensions and can be solved with different approaches, methods and algorithms, depending on the complexity of the given planning problem. So called rich problems have different - sometimes contrary constraints and can influence the possibility to use one or another algorithm more or less significant. Thus the various planning systems use different algorithms for the calculation of planning solutions respectively routing options. In an operative setting real world problems have to deal in most cases with no unlimited homogeneous fleet. Instead of that most often different types of vehicles and limited availabilities are given. It goes without saying that this probably imposes new constraints and new aspects on the original problem

Further aspects of richness are the presence of multiple customer time windows with different kinds of service. In real world problems it can be distinguished between start of service intervals and full service intervals. The correct handling of working hours regulations increases the degree of complexity considerably.

Often real world problems do not focus on one problem but deal a multiple objectives, e.g. service level, social criteria, robustness, ecological criteria and visual attractiveness. In most of the cases the core algorithms of the systems are not known to the public which makes detailed analyses of the capabilities of such systems very difficult.

This section aims to know whether VRP is one of the goals of the TMS software package. The findings of the survey for this dimension are given in **Table 2**.

Table 2: Vehicle routing capability

No	Software Package	Dimension
1	Direct Route	Yes
2	INTRIS	Yes
3	Sterling Transportation Management System	Yes
4	Optrak Routing & Scheduling	Yes
5	ORTEC Transport and Distribution	Yes
6	Logistics Planning Solutions	Yes
7	Trampas	Yes
8	Show Trip, Controller	Yes
9	SAP TM	Yes
10	PRA Car 3000	Yes
11	LS/ATN	Yes
12	Descartes Delivery Management Suite	Yes
13	4S Shipper Logistics	Yes
14	Paragon routing	Yes
15	Kewill Transport	Yes
16	WORKsmart	Yes
17	PTV Map & Guide	Yes
18	PTV Smartour	Yes
19	Transport Management	Yes
20	Roadnet	Yes
21	COSware	Yes
22	Cargo Online	Yes
23	CargoSoft SCM	Yes
24	TMS(Greencat)	Yes
25	Netmover	Yes
26	TransWareOne	Yes
27	HighJump Transportation Advantage	Yes
28	L-wiS	Yes
29	i2 Transportation Manager (referred as JDA)	Yes
30	inet TMS	Yes
31	ASSIST4	Yes
32	TMS(DDS)	Yes
33	LeanTMS	Yes
34	Voyager Transportation Planning & Management	Yes
35	Transportation Planning & Execution	Yes
36	Cofano logistic suite	Yes
37	IXTransport operator	Yes
38	C-logistic and C-sped	Yes

39	Komalog	Yes
40	Transworks TMS	Yes
41	TourboRoute	Yes
42	Xcargo	Yes
43	Spedipro 5.0i	Yes
44	FLS visitour	Yes
45	InconsoTMS	Yes
46	CargobaseTMS	Yes
47	SNC Cargo	Yes
48	LBASE 6	Yes
49	DisponentPlus	Yes

In most of the cases the general VRP is being addressed by all of the analysed tools. This was expected since VRP forms the base for routing problems. Some of the parameters observed pointed out that, TMS packages of ORACLE and SAP for e.g., considered load building factors and carrier selection options which are part of the objective function in a VRP. Also, these TMS's have the provision to connect to a company's ERP system.

2.2 Online/Offline Planning

Once we know that a TMS considers VRP as its goal, we then try to understand how the planning of the route and other things takes place. Generally, there are two types of planning, namely Offline Planning and Online Planning.

In Offline planning, all forms of input information are required in advance. i.e., you can execute the planning operation only if you have information in advance and real-time data cannot be used.

In Online planning, available real-time information can be considered which helps to adjust planning solutions and making it more precise and effective. The planning is started with the available information and is further processed/improved with the real-time data provided to the software, which finally executes the planning. **Table 3** lists the survey on Online planning capability of TMSs.

Table 3: Online Planning Capability

No	Software Package	Dimension
1	Direct Route	Yes
2	INTRIS	Yes
3	Sterling Transportation Management System	Yes
4	Optrak Routing & Scheduling	Yes
5	ORTEC Transport and Distribution	Yes
6	Logistics Planning Solutions	Yes
7	Trampas	Yes
8	Show Trip, Controller	Yes
9	SAP TM	Yes
10	PRA Car 3000	Yes
11	LS/ATN	Yes
12	Descartes Delivery Management Suite	Real-world information included
13	4S Shipper Logistics	Yes
14	Paragon routing	Yes
15	Kewill Transport	Yes
16	WORKsmart	Yes
17	PTV Map & Guide	Yes, includes historical and actual traffic information
18	PTV Smartour	Yes, includes historical and actual traffic information
19	Transport Management	-
20	Roadnet	Yes
21	COSware	Yes
22	Cargo Online	-
23	CargoSoft SCM	-
24	TMS(Greencat)	Board computer with TMC for online
25	Netmover	Yes
26	TransWareOne	-
27	HighJump Transportation Advantage	Yes
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	Dynamic as well as strategic
30	inet TMS	Yes
31	ASSIST4	Yes
32	TMS(DDS)	Yes
33	LeanTMS	Yes
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	Yes
36	Cofano logistic suite	Offline
37	IXTransport operator	Yes
38	C-logistic and C-sped	-
39	Komalog	Yes
40	Transworks TMS	Realtime ETA calculator
41	TourboRoute	-
42	Xcargo	-
43	Spedipro 5.0i	-
44	FLS visitour	-
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	Yes
48	LBASE 6	Yes
49	DisponentPlus	Yes

It can be observed from the above table that majority of the TMS's have the provision to perform online planning.

2.3 Optimization Algorithms

As mentioned earlier in the first dimension, the complexity of the planning increased as the size of the shipments increased. With increasing complexity, the problem turns into nondeterministic polynomial time that is very difficult to solve in a reasonable time. The amount of time to be spent increases exponentially with every shipment and in most of the cases-problem cannot be solved with an exact and optimal end result.

Hence, there exists many heuristics, which promise to provide solutions close to the best possible solution. Each TMS has its own combination/ single heuristic(s), which is using a specific optimization algorithm. These optimization algorithms are one of the key parts of a TMS. These optimization algorithms are what improve the solution to the best extent possible. Optimization algorithms are in many cases the core component of TMS. **Table 4** lists the survey findings on optimization algorithms.

Table 4: Optimization Algorithm(s) used

No	Software Package	Dimension
1	Direct Route	-
2	INTRIS	-
3	Sterling Transportation Management System	Based on IBM ILOG optimization engine
4	Optrak Routing & Scheduling	Genetic algorithm
5	ORTEC Transport and Distribution	-
6	Logistics Planning Solutions	Cplex
7	Trampas	Natural analog algorithms(genetical)
8	Show Trip, Controller	-
9	SAP TM	Constraint-based, cost, service constraint
10	PRA Car 3000	-
11	LS/ATN	Continuous optimization, continuously enlarging search scope to avoid local optima
12	Descartes Delivery Management Suite	-
13	4S Shipper Logistics	Heuristic
14	Paragon routing	-
15	Kewill Transport	-
16	WORKsmart	-
17	PTV Map & Guide	Meta-heuristics
18	PTV Smartour	Comb. of meta heuristics, solvers etc.
19	Transport Management	Fico XPress optimizer solves LP, MIP, QP, MIQP, QCQP, MIQCQP, Convex NLP
20	Roadnet	-
21	COSware	-
22	Cargo Online	-

23	CargoSoft SCM	-
24	TMS(Greencat)	Heuristics: 2 steps: 1) assignment of customers to tours 2) routing of all existing tours calculation of shortest tours
25	Netmover	-
26	TransWareOne	-
27	HighJump Transportation Advantage	-
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	Constraint based, fewest routes, least distance shortest time, then real-time orders and driver preferences
30	inet TMS	-
31	ASSIST4	-
32	TMS(DDS)	-
33	LeanTMS	Heuristic
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	Multimodal using historical rates
36	Cofano logistic suite	-
37	IXTransport operator	-
38	C-logistic and C-sped	-
39	Komalog	-
40	Transworks TMS	-
41	TourboRoute	-
42	Xcargo	PTV intertour
43	Spedipro 5.0i	-
44	FLS visitour	PowerOpt heuristic, able to adapt to real-time changes of planned situation by re-calculation
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	-
48	LBASE 6	-
49	DisponentPlus	-

2.4 Multi-objective optimization

As described in previous section various optimization techniques are used to obtain a good solution for the planning problem. In this section, the possibility to consider Multi-objective optimization is being analysed. With every increase of variable in an objective function, the harder it gets to obtain a good solution. Multi-objective optimization analyses to what extent can we consider different objectives and optimize them together keeping in mind various constraints. Many prefer to keep the number of objectives to as minimum as possible to reduce the complexity. However, this is not always the case in real-life. Often, there are more than two objectives that are necessary to be considered at the same time for a better solution. **Table 5** below shows the various objectives considered by each TMS software package.

Table 5: Multi-objective optimization capability

No	Software Package	Dimension
1	Direct Route	-
2	INTRIS	-
3	Sterling Transportation Management System	Cost
4	Optrak Routing & Scheduling	-
5	ORTEC Transport and Distribution	Cost
6	Logistics Planning Solutions	Yes
7	Trampas	-
8	Show Trip, Controller	-
9	SAP TM	Cost
10	PRA Car 3000	Distance, time, cost plus constraints
11	LS/ATN	Cost
12	Descartes Delivery Management Suite	-
13	4S Shipper Logistics	Cost, time
14	Paragon routing	Efficiency, fleet utilization
15	Kewill Transport	-
16	WORKsmart	Time
17	PTV Map & Guide	Time, distance, cost(combination of first two), vehicle deployment, equal capacity distribution
18	PTV Smartour	Time, distance, cost(combination of first two), vehicle deployment, equal capacity distribution, constraints, parameter set for vehicles etc. (see chapter 6)
19	Transport Management	Yes: cost, service levels and asset utilization
20	Roadnet	Cost, time and distance
21	COSware	Time, distance, cost, service level
22	Cargo Online	
23	CargoSoft SCM	-
24	TMS(Greencat)	Distance and waiting time
25	Netmover	Cost plus constraints
26	TransWareOne	-
27	HighJump Transportation Advantage	Cost, service level plus constraints
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	Yes: cost, service level., time and distance
30	inet TMS	-
31	ASSIST4	-
32	TMS(DDS)	Cost, time, quality
33	LeanTMS	Cost plus constraints
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	Quality, cost, speed
36	Cofano logistic suite	-
37	IXTransport operator	-
38	C-logistic and C-sped	-
39	Komalog	-
40	Transworks TMS	-
41	TourboRoute	Time,distance, costs,including toll costs and considering restrictions
42	Xcargo	Costs plus constraints
43	Spedipro 5.0i	-
44	FLS visitour	Revenue, cost, service times
45	InconsoTMS	Cost
46	CargobaseTMS	-

47	SNC Cargo	-
48	LBASE 6	Distance, time
49	DisponentPlus	-

It can be seen that only few TMS packages make an effort to consider multi-objective optimization that includes PTV Map&Guide and PTV Smartour, COSware, TurboRoute etc. It requires having robust optimization algorithms when considering Multi-objective optimization

2.5 Inter-modal trip planning

One of the phases of planning is the consideration of different modes of transport. When planning a route between two points (say A and B) it may be necessary to use more than one mode of transport for the entire journey. As much as it is necessary to use more than one mode of transport for geographical reasons, it is also necessary to consider this option for accommodating different types of load, size, shape etc., of the goods being transported.

For a factor as important as this, it becomes essential that when planning, all possible solutions including Inter-modal trip planning can be considered. When this type of planning is considered, it becomes essential to generate a link between two different modes of transport (when used). These considerations have to be kept in mind while generating the plan.

An example: the requirement is that goods to be moved from point A to point B. it is learnt that it can be transported via truck however, after further analysis, it was realized that a more efficient way is available which includes transportation of goods from point A to point C via truck, then from point C to point B via Rail (train). In this case, the necessary connection (or link) between the truck and the train is required when it is transferred. **Table 6** shows the capabilities of being able to consider inter-modal trip planning of each TMS.

Table 6: Inter-modal trip planning capability

No	Software Package	Dimension
1	Direct Route	-
2	INTRIS	-
3	Sterling Transportation Management System	Yes
4	Optrak Routing & Scheduling	Yes
5	ORTEC Transport and Distribution	Yes
6	Logistics Planning Solutions	Yes
7	Trampas	-
8	Show Trip, Controller	Yes
9	SAP TM	Yes
10	PRA Car 3000	-
11	LS/ATN	Yes, for all modes of transport
12	Descartes Delivery Management Suite	Yes
13	4S Shipper Logistics	Yes
14	Paragon routing	-
15	Kewill Transport	-
16	WORKsmart	-
17	PTV Map & Guide	Yes
18	PTV Smartour	Yes
19	Transport Management	Yes
20	Roadnet	-
21	COSware	-
22	Cargo Online	Yes
23	CargoSoft SCM	Yes
24	TMS(Greencat)	Yes (Cat4TransportOperator)
25	Netmover	Yes
26	TransWareOne	Yes
27	HighJump Transportation Advantage	Yes
28	L-wiS	Yes
29	i2 Transportation Manager (referred as JDA)	-
30	inet TMS	-
31	ASSIST4	-
32	TMS(DDS)	Yes
33	LeanTMS	Yes
34	Voyager Transportation Planning & Management	Yes
35	Transportation Planning & Execution	Yes
36	Cofano logistic suite	Yes
37	IXTransport operator	Yes
38	C-logistic and C-sped	-
39	Komalog	-
40	Transworks TMS	Yes
41	TourboRoute	-
42	Xcargo	-
43	Spedipro 5.0i	-
44	FLS visitour	-
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	-
48	LBASE 6	-
49	DisponentPlus	Yes, Ortec TD

It is seen from the above table that around 2/3rd of the TMS's have provisions for including inter-modal transport planning. TMS packages of "DBH Logistics", "Replica Sistemi", "Descartes", "Tesi" in particular have provisions for using Sea, Air, Road and Rail modes of transport which is quite good. This provides more options to the end users.

2.6 Green Logistics (Carbon footprint measurement)

Carbon footprint measurement is becoming more and more important in the field of transport and logistics. Therefore CO₂ emissions as one of the major greenhouse gases, have to be calculated. Route planning and scheduling being the main purpose of TMS software packages, and the use of trucks, air freight, sea freight (which form the integral part of transportation planning) being the main contributors for greenhouse gas emission, this forms an important dimension to be included in this project.

In the initial phases, various organizations have made an effort to measure the emission. I. Hence, the following table shows list of TMS's which are equipped with carbon footprint measurement technology, which will further indicate the amount of CO₂ emissions, caused by the entire route planning or by a particular mode of transport. In the next step, emissions can be compared and evaluated with regard to the mode of transport. **Table 7** shows the capabilities of TMS software's on emissions calculation.

Table 7: Carbon footprint measurement/calculation

No	Software Package	Dimension
1	Direct Route	-
2	INTRIS	-
3	Sterling Transportation Management System	-
4	Optrak Routing & Scheduling	-
5	ORTEC Transport and Distribution	Takes into consideration
6	Logistics Planning Solutions	Focus on carbon emission
7	Trampas	Yes
8	Show Trip, Controller	-
9	SAP TM	CO ₂ emissions, add-ons detailed calculation from parcon consult
10	PRA Car 3000	-
11	LS/ATN	Provision for focus on carbon emission
12	Descartes Delivery Management Suite	Yes
13	4S Shipper Logistics	-
14	Paragon routing	-
15	Kewill Transport	-
16	WORKsmart	Yes
17	PTV Map & Guide	Calculation of emissions, provide certificate
18	PTV Smartour	Calculate emissions for different modes of

		transport
19	Transport Management	Add-on environmental accounting and reporting to E-Business Suite
20	Roadnet	Basic calculator online
21	COSware	-
22	Cargo Online	-
23	CargoSoft SCM	-
24	TMS(Greencat)	-
25	Netmover	Yes
26	TransWareOne	Yes
27	HighJump Transportation Advantage	-
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	-
30	inet TMS	-
31	ASSIST4	-
32	TMS(DDS)	-
33	LeanTMS	-
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	-
36	Cofano logistic suite	Yes
37	IXTransport operator	Yes
38	C-logistic and C-sped	-
39	Komalog	-
40	Transworks TMS	-
41	TourboRoute	-
42	Xcargo	Yes
43	Spedipro 5.0i	-
44	FLS visitour	-
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	-
48	LBASE 6	-
49	DisponentPlus	Yes, CO ₂ calculator

The table shows that almost half of the listed TMS packages have taken steps to measure the greenhouse gas emission resulting from the planning. TMS package from ORACLE is equipped with carbon footprint measuring instrument that also connects and updates the E-business suite of the parent organization.

2.7 Congestion/Time dependency

Another important dimension is the ability to integrate traffic information in the planning and monitoring process. **Table 8** shows the capabilities on congestion in their planning of each TMS.

Table 8: Adaptation to Congestion incidents

No	Software Package	Dimension
1	Direct Route	-
2	INTRIS	-
3	Sterling Transportation Management System	-
4	Optrak Routing & Scheduling	Yes
5	ORTEC Transport and Distribution	Congestions function(historical, real-time information, predictive info like weather), time dependent order sizes
6	Logistics Planning Solutions	-
7	Trampas	-
8	Show Trip, Controller	-
9	SAP TM	-
10	PRA Car 3000	-
11	LS/ATN	-
12	Descartes Delivery Management Suite	Time and road type sensitive speed profiles
13	4S Shipper Logistics	-
14	Paragon routing	-
15	Kewill Transport	-
16	WORKsmart	Yes
17	PTV Map & Guide	Yes, average traffic density
18	PTV Smartour	Yes, historical traffic information
19	Transport Management	-
20	Roadnet	-
21	COSware	-
22	Cargo Online	-
23	CargoSoft SCM	-
24	TMS(Greencat)	-
25	Netmover	-
26	TransWareOne	-
27	HighJump Transportation Advantage	-
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	-
30	inet TMS	-
31	ASSIST4	-
32	TMS(DDS)	-
33	LeanTMS	-
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	-
36	Cofano logistic suite	-
37	IXTransport operator	Yes
38	C-logistic and C-sped	-
39	Komalog	-
40	Transworks TMS	-
41	TourboRoute	-
42	Xcargo	-
43	Spedipro 5.0i	-
44	FLS visitour	-
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	-
48	LBASE 6	-
49	DisponentPlus	-

2.8 Synchromodal trip planning

Another level of Inter-modal trip planning is the recent development of Synchromodal trip planning. In synchromodal trip planning, the planning with different modes of transport is not sequential. i.e., instead of planning from Point A to Point B with truck and then from Point B to Point C with air, synchromodal planning executes this operation by planning from Point A to Point C simultaneously with both Air and Truck in parallel. Table shows the findings on synchromodal trip planning of each TMS.

Table 9: Synchromodal trip planning capability

No	Software Package	Dimension
1	Direct Route	-
2	INTRIS	-
3	Sterling Transportation Management System	-
4	Optrak Routing & Scheduling	-
5	ORTEC Transport and Distribution	-
6	Logistics Planning Solutions	-
7	Trampas	-
8	Show Trip, Controller	-
9	SAP TM	Singlestep and stage-wise
10	PRA Car 3000	-
11	LS/ATN	Developing stages
12	Descartes Delivery Management Suite	-
13	4S Shipper Logistics	-
14	Paragon routing	-
15	Kewill Transport	-
16	WORKsmart	-
17	PTV Map & Guide	As a prototype
18	PTV Smartour	As a prototype
19	Transport Management	-
20	Roadnet	-
21	COSware	-
22	Cargo Online	-
23	CargoSoft SCM	-
24	TMS(Greencat)	-
25	Netmover	-
26	TransWareOne	-
27	HighJump Transportation Advantage	-
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	-
30	inet TMS	-
31	ASSIST4	-
32	TMS(DDS)	-
33	LeanTMS	-
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	-
36	Cofano logistic suite	Yes
37	IXTransport operator	-
38	C-logistic and C-sped	-
39	Komalog	-

40	Transworks TMS	-
41	TourboRoute	-
42	Xcargo	-
43	Spedipro 5.0i	-
44	FLS visitour	-
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	-
48	LBASE 6	-
49	DisponentPlus	-

Since this is a recent development and new technique, not many TMS's are equipped to use synchromodal trip planning. CSD-logistik is one of the groups who are currently equipped with this type of planning. They optimize the network of Swiss cargo (Europe) and Schenker rail and forwarding (Europe and Asia).

2.9 Event handling

An event handling shows the ability to incorporate events associated with particular mode of transport (for e.g., rail work etc.). **Table 10** gives the detail on event handling capacity for each TMS.

Table 10: Event Handling Capability

No	Software Package	Dimension
1	Direct Route	Planned vs. actual
2	INTRIS	Handled by continuous feedback loop
3	Sterling Transportation Management System	Planned vs. actual alerts
4	Optrak Routing & Scheduling	Planned vs. actual alerts
5	ORTEC Transport and Distribution	Automated or (semi-manual) alerts from planned vs. actual comparison.
6	Logistics Planning Solutions	-
7	Trampas	Target performance comparison
8	Show Trip, Controller	Target performance comparison
9	SAP TM	Flexible automated workflows dependent on status, deviations in own or partners systems e.g. refer, time
10	PRA Car 3000	Target-performance comparison
11	LS/ATN	Real-time replanning in case of order changes and unexpected events, order related, capacity related
12	Descartes Delivery Management Suite	-
13	4S Shipper Logistics	Event management, monitoring of transport status in real time
14	Paragon routing	Planned vs. actual alerts
15	Kewill Transport	Alerts based on planned vs. actual comparison

16	WORKsmart	Automated rerouting with real-time traffic information(IQ routes and HD traffic)
17	PTV Map & Guide	Interface from planning system to different telematics system available. Trip amendment due to new order sensor status, e.g., opening of tank cap, driving at restricted times, geofencing etc.,
18	PTV Smartour	Interface from planning system to different telematics system available. Trip amendment due to new order sensor status,
19	Transport Management	Add-on supply chain management
20	Roadnet	Planned vs. actual manage by exception
21	COSware	Target-performance comparison
22	Cargo Online	-
23	CargoSoft SCM	-
24	TMS(Greencat)	Trailer temperature
25	Netmover	-
26	TransWareOne	-
27	HighJump Transportation Advantage	Alert at exception, notification of expected event, planned vs. actual
28	L-wiS	-
29	i2 Transportation Manager (referred as JDA)	Variation in store and customer volumes, resource availability, late orders, backhauls, exception management
30	inet TMS	Alerts from planned vs. actual deviations
31	ASSIST4	Alerts point out deviation from expectations
32	TMS(DDS)	Alerts point out deviation from expectations
33	LeanTMS	Alerts based on planned vs. actual comparison
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	Alerts point out deviation from expectations(real-time info on orders and assets)
36	Cofano logistic suite	-
37	IXTransport operator	Pro-active information about deviations, anomalies, late deliveries
38	C-logistic and C-sped	-
39	Komalog	Target-performance comparison, including congestion and defective transport assets
40	Transworks TMS	Target-performance comparison, exception management
41	TourboRoute	-
42	Xcargo	-
43	Spedipro 5.0i	-
44	FLS visitour	-
45	InconsoTMS	-
46	CargobaseTMS	-
47	SNC Cargo	Unexpected events can be assessed in real-time, real-time info from truck
48	LBASE 6	Real time ETA calculation
49	DisponentPlus	GPS based real-time calculation of ETA

2.10 Message processing/integration (telematics)

Message processing is an approach used within the client/server computing model in which a client sends a service request in the form of a specially-formatted message to a program that acts as a request broker, handling messages from many clients intended for many different server applications. The recipients of the message can be application, shipper, planner, driver or governmental authorities. The findings of this dimension are listed in **Table 11**.

Table 11: Telematics

No	Software Package	Dimension
1	Direct Route	Yes
2	INTRIS	Yes
3	Sterling Transportation Management System	Yes
4	Optrak Routing & Scheduling	Yes
5	ORTEC Transport and Distribution	Yes
6	Logistics Planning Solutions	-
7	Trampas	Yes
8	Show Trip, Controller	Yes
9	SAP TM	Yes
10	PRA Car 3000	Yes
11	LS/ATN	Yes
12	Descartes Delivery Management Suite	Yes
13	4S Shipper Logistics	Yes
14	Paragon routing	Yes
15	Kewill Transport	Yes
16	WORKsmart	Yes
17	PTV Map & Guide	Yes
18	PTV Smartour	Yes
19	Transport Management	Yes
20	Roadnet	Yes
21	COSware	Yes
22	Cargo Online	-
23	CargoSoft SCM	-
24	TMS(Greencat)	Yes, board computers(also for trailers)
25	Netmover	Yes
26	TransWareOne	Yes
27	HighJump Transportation Advantage	-
28	L-wiS	Yes
29	i2 Transportation Manager (referred as JDA)	Yes
30	inet TMS	Yes
31	ASSIST4	-
32	TMS(DDS)	-
33	LeanTMS	-
34	Voyager Transportation Planning & Management	-
35	Transportation Planning & Execution	Yes
36	Cofano logistic suite	-
37	IXTransport operator	-
38	C-logistic and C-sped	Yes
39	Komalog	Yes
40	Transworks TMS	Yes

41	TurboRoute	Yes
42	Xcargo	-
43	Spedipro 5.0i	Yes
44	FLS visitour	Yes
45	InconsoTMS	Yes
46	CargobaseTMS	Yes
47	SNC Cargo	Yes
48	LBASE 6	Yes
49	DisponentPlus	Yes

3 Online Freight Platforms

One substantial part of the GET-Service Platform will be an online freight platform. This platform is a form of market place that matches supply with demand. Thereby, the transport assets of logistics providers are automatically and according to specified conditions and preferences matched with the individual transport orders. Already existing platforms also have a market place as the core piece of their solution. These market places enable the users to manually organize their transport orders by using available assets. The platform, in the process, provides decision support for the user.

Such online platforms have a variety of advantages, which a number of different users can benefit from. Potential economies of scale due to planning across the boundaries of single businesses enable a higher utilization of assets and less empty trips. This not just benefits the asset-holder (logistics provider). Also the shipper benefits due to reduced costs as well as guaranteed financial security by the platforms. Increasing transport opportunities, especially in case of vehicle breakdowns or other bottlenecks, also ensure a higher reliability. Last but not least, increasing market transparency due to these platforms decrease dependencies as well as price variability.

In combination with the capabilities of a TMS, such online platforms can be even more valuable. TMS not just provide advanced planning and routing algorithms necessary for the efficient matching of supply and demand, they also help controlling and tracking the shipments. On-time freight controlling, thereby, on one hand enables quick action in case of disruptions while on the other hand facilitating a performance analysis of the transport possible.

The following overview describes some already established online freight platforms in order to analyse the current market capabilities in this sector. It focuses on platforms that are widespread solutions. Most of them also enable the integration with TMS.

3.1 Teleroute

3.1.1 Basic Information:

Solution name: Teleroute Freight Exchange

Link: http://teleroute.co.uk/en_gb

This freight exchange platform, which operates in 27 European countries and has its head office in the Netherlands, was founded in 1985. It handles 200,000 offers a day, resulting in 1.2 million tons of freight a year, and is used by 70,000 users (based on data from 2011). As Software as a Service (SaaS) it is used over the web browser and is suited for the transport mode road. It can be integrated into TASTms and PTV's Map&Guide and is available as Teleroute Pro, where customers only pay for offers they are interested in or Teleroute Active, which is suited for large amounts of loads.

A few special features of this platform include the STAR rating, which provides a reliability rating of transport service providers (TSP). These include reliability data from its electronic order management software e-Confirm as well as the usual customer ratings. Helvetia insurance company gives freight theft insurance. Teleroute enables the incorporation of a list of preferred business partners. It provides financial ratings in exchange for a small fee and also calculates routes for the trucks.

3.1.2 Functionalities

- Transport Company Directory: Every registered user has a Teleroute ID and an entry including information like key contacts, address information, preferred languages, regular routes, warehouse facilities and an address book of individually preferred partners.
- Preferred or Non-Preferred partners: Optimization of search results with these partner lists. Search results of preferred partners are highlighted.
- Route planner (free): Calculates routes for orders. Is based on map&guide material and is able to incorporate multiple stops. Also mapping features are available.
- SMS (free): Offer details are sent to drivers for free.
- Document Upload (free)
- Planner's perspective: Matching offers pop up when entered. Six trucks can be filled up simultaneously. Teleroute calculates routes and costs, including some toll costs (especially for Germany). A perimeter search can be conducted revealing all available offers in a user-specified perimeter.

3.1.3 Security

- 99.99% secure through Safe Market Place programme. In case of unpaid bills or missing freight, Teleroute directly intervenes with a success rate of above 80%. In 2011 1million € were recovered.
- Each registering company is verified against public and business databases. The verification takes place on three levels. Each registered company can see the verification level of the company it's dealing with.
- An International Business Security Panel manages conflicts between members and might exclude companies from Teleroute.
- Each registered party can sign a non-mandatory code of conduct. Signing companies are highlighted and can be excluded for breaches.
- E-Confirm automatically shares contact details and transportation documents when a deal is agreed upon, and users are insured against theft and can use the debt mediation service.
- Freight theft insurance (Helvetia) is provided for companies doing business in the EU, Norway or Switzerland. The insurance amount is up to 50,000 € per claim.
- Financial ratings: For a small fee (3€ domestic, 7€ international) information about credit ratings, revenue and profit data is given via Creditsafe (see <http://www1.creditsafede.com/>).
- Debt mediation by Teleroute team: By means of negotiation, suspension and termination of contracts Teleroute provides mediation for conflicting parties.
- STAR (Safety Transport Algorithm Rating) is an index reflecting your reliability. Thereby the online confirmation data from e-Confirm and customer reviews as well as entries on lists of preferred partners are included as criteria.

3.2 Transporeon

3.2.1 Basic Information

Solution name: TRANSPOREON

Link: <http://www.transporeon.com/en/services.html>

This freight exchange platform, which operates in 80 countries and has its head offices in Ulm as well as Kempten (both in Germany) was founded in 2000. It has 850 shippers, 40,000 carriers with a total of 100,000 users resulting in 2 billion € of transport volume a year. As a Software as a Service (SaaS) it is used over the web browser and is suited for the transport modes road, rail, waterways and air. The TMS partners include PTV, Dr. Malek, Wanko, Soloplan, Cargo Support and Gehr Business Solutions. A tendering platform (Ticontract) and a trading companies logistics platform (MERCAREON) are also available.

A few special features of this platform include the time-slot booking functionality, which helps to reduce waiting times at docks, and the transport market monitor, which helps to keep an overview of transport prices on the market.

3.2.2 Functionalities

- Time slot booking for delivery control.
- Transport assignment to a closed pool of carriers. Options:
 - Best carrier: Put order online and choose from responses of carriers with the best one being most likely the one who reduces empty miles most efficiently.
 - No-touch order: This option automatically assigns orders to carriers, based on contractually agreed prices or quantity commitments. If carrier declines, system takes next carrier.
 - Dynamic contract: This option includes day-to-day order placement in contracts, shippers get offers within 10-15min since carrier can reply with pre-specified quotations. Carriers can easily combine many shipments to one load, also inserting into existing routes
- Transport visibility including status messages: Delays are recognized early. Telematics systems can be incorporated. Carriers can inform about traffic jams or excessively long border controls. The status can be entered by phone, entering the customer, transport and status number.
- Reporting: Key indicators as well as additional information for decision-makers are being reported. An export to Excel can be generated. Also information about carriers (how often accepted/declined as carrier) and specific offers (accepted/declined) is gathered.

- A Transport Market Monitor keeps track of market indices like transport prices, capacities and price differences.
- SMS functionality to communicate with drivers about orders.
- Trailer management

3.2.3 Security

- Transport Service Providers have to be authorized by the shippers to see their offers. Thus, security depends on the choice of shippers.

3.3 Timocom

3.3.1 Basic Information:

Solution name: TC Truck&Cargo

Link: <http://www.timocom.co.uk/>

This freight exchange platform, which operates in 50 countries (Europe according to the broader definition of Europe, but also China and Armenia) and has its head office in Düsseldorf (Germany) was founded in 1997. It has 300,000 offers of freight and vehicles per day, 30,000 transport service providers with a total of 85,000 users resulting in 516 million tons of transport volume a year (based on data from 2010). As a Software as a Service (SaaS) it is used over the web browser and is suited for the transport modes road, rail, waterways and air.

A few special features of this platform include TC eMap, which allows for the integration of conventional telematics solutions into TC Truck&Cargo for real-time tracking of vehicles, and Closed User Groups (CUG), which are user-specified subgroups of all companies participating in TC Truck&Cargo. In this system, the members of a user group get notified beforehand, so that the likelihood of a company from the CUG responding to a request at first increases.

3.3.2 Functionalities

- Offers information about the type of transport vehicle as well as information on destination, in-transit requirements, and also information about size, type and weight of the freight shipped. Information on the vehicle includes location, destination and when it is available
- TC Profiles: 30,000 company profiles are compiled, including information about regular routes, fleet, special loads and storage facilities.
- Mobile phone access to free offers of freight and vehicles, using Timocom ID and user ID.
- Warehousing exchange tool included, free warehouse capacities can be published.
- Closed User Groups can be built and form an exchange inside the exchange with just a selection of companies included in the CUG. If no reply comes from CUG, also widening the search onto the normal TC platform is possible.
- TC Connect: A solution to connect company-sofwareas automatically to Truck&Cargo.
- Perimeter search, with a maximum perimeter of 200km from start or destination postcode is possible.
- TC eMap: Routing software that integrates conventional telematics systems manufacturer-independently. Trip and additional costs can be calculated. Mapping capabilities are available.

- Tendering Platform TC eBid: Tendering Process:
 - 1) Data preparation and needs specification
 - 2) Selection from the potential 30,000 service providers
 - 3) Tender start
 - 4) Bidding phase with permanent status and information feedback
 - 5) Offer evaluation and contract negotiation
- Input for tender:
 - 1) Countries served (from, to)
 - 2) Nature of business (incl. land, sea, inland waterways, air, disposal, courier, LSP, warehouse-provider, Freight forwarder)
 - 3) Type of load (incl. full, groupage, express, parcel, part load, special, courier)
 - 4) Vehicle type (trailer, car, small vehicle, wagon, other)
 - 5) Vehicle body type (container, flatbed, silo, etc.)
 - 6) Nature of cargo (normal, bulk, heavy, chilled, hazardous, etc.)
 - 7) Type of cargo (merchandise, food, waste etc.)

3.3.3 Security

- TC Secure
 - Access check
 - Companies need to be older than 6 months
 - Examination of business documents
 - Verification of every new customer
 - Permanent customer controlling
 - TC CashCare: Debtors are contacted by TC lawyers with success rate of 88%. Legal advice is provided. The processing fee is 15€
 - IT Security (Servers etc.) is provided.
 - TC Login: Personal security key without the need for a username/password combination.

3.4 wtransnet

3.4.1 Basic Information

Solution name: Cargo: Freight and Truck Exchange

Link: <http://www.wtransnet.com/en/hauliersandexchanges.html>

This freight exchange platform, which operates in 23 countries (Europe and Latin America) and has its head office in Barcelona in Spain was founded in 1996. It has 9,000 customers. As a Software as a Service (SaaS) it is used over the web browser and is suited for the transport mode road.

Special features of this platform include an online payment guarantee, insured by the insurance company Coface, the possibility to participate in private freight exchanges with only selected companies in one group in the package Cargo PLUS and a special freight exchange for long-term contracts (package Contract).

3.4.2 Functionalities

- An Online Payment Guarantee service, through the insurance company Coface or a bank guarantee, is available.
- User profiles inform e.g. about the date of constitution of the company and if the company is authorized by wtransnet to offer loads. Further information includes contact details as well as fiscal and invoicing data. Each user has an own contact list.
- Check of transport documents.
- White list with companies with lower payment terms.
- Cargo offers the real-time matching of multiple freight orders per truck/multiple trucks per freight order. The six criteria for matching are:
 - Same date and hour
 - Type of exchange
 - Same type of truck
 - Same or compatible specialty
 - Same way of loading
 - Same route
- Users are alerted via SMS, email, or instant message of new matching offers.
- Handles three types of exchanges:
 - Full trailer
 - Partial loads
 - Full rigid

- System indicates (by use of an icon) if tracking system is installed in truck
- Search settings include the following possibilities:
 - Hazardous Material
 - Tail lift
 - Required equipment
 - Urgent service
 - Need for two drivers
- Offers are archived. Old offers are deleted after a pre-specified time
- Automatic distance calculation
- Templates for transport offers reduce the amount of data entry required.
- Package “Cargo PLUS”: Private exchange with known companies, used before offers are pushed into public freight exchange
- Package “Contract”: Exchange for medium to long-term contracts, not only for driver and truck, but also frequent routes.
- Package “Car Transport”: Specialized on car transporters
- Free company information via telephone including simultaneous translation services via telephone in 7 languages (for extra cost).
- A list of withdrawn companies is accumulated.

3.4.3 Security

- New clients are filtered by their solvency and reliability via verification of identity, documentation and commercial checks. The evaluation takes place by the Coface insurance company or by a submitted bank guarantee. Wtransnet denies access with expired documentation. In 2010 of 3,400 applications, only 1,228 were accepted.
- Recommendations by other companies are transparent to others.
- Control of expiration dates of documents is given.
- Monitoring of behaviour and breach reports is given.
- Management of incidents with debt mediation is offered (free of charge).

4 A detailed description of PTV Solutions

4.1 PTV Map & Guide

4.1.1 Basics

PTV Map&Guide solution is a transport route planner which calculates the optimal route. It considers all of the relevant data in the process such as truck and hazardous goods restrictions, individual vehicle profiles and transport and toll costs – and optimises the sequence of the stops. This saves detours, costs and time. The software solution is available in 3 different versions and can cover different map data and areas.

4.1.2 Features

The software provides the following functionalities:

- Truck route calculation - efficient truck route planning
- Toll and transport cost calculation
- Sequence and time slot optimization
- Calculation of emissions
- Display and classification of customer data

For the truck route calculation PTV Map&Guide calculates the optimal route for trucks, taking into account:

- Official truck and hazardous goods data – throughout Europe, including: restrictions in height, width, length, total weight and axle load;
- Transit bans (e.g. > 3.5 t trailers and hazardous goods transports), other restrictions, such as “residents only”, permanent roadworks, long-term road closures and the latest traffic reports.
- The prescribed driving and rest periods as well as remaining driving and shift times of drivers, personally customised blocked roads and weightings, individual preferences (e.g., allow arrivals and departures in restricted zones or avoid ferries and toll roads)
- Alternative routes
- Low-emission zones.

Toll and transport cost calculation within PTV Map&Guide takes into account all expected costs, enabling precise planning beforehand and smoothly process invoices:

- Regularly updated toll tariffs, future tariff changes or the introduction of new toll systems for many European countries, including tolls for trunk roads, motorways and special tolls, e.g.

for tunnels, bridges and inner cities. The software also takes into account surcharges for freight and for individual costs, e.g. based on distance or stops

- Time and costs due to additional time spent at stop-off points as well as driving time and breaks
- Save rates per mile based on the distance or tariff-zone system to simplify the calculation of transport services

Sequence optimization in Map&Guide plans the best possible sequence of stop-off points, including individual time slots, enabling to call on more customers in less time:

- Calculation based on the miles that have to be covered and/or time slots during which the customers want deliveries to be made
- It also takes into account opening times and time-slot systems for deliveries (to warehouses)
- Reduces waiting times at the ramp

Emission calculation in PTV Map&Guide automatically displays all of the emissions for a calculated route:

- Depending on the vehicle configuration, its unladen weight, the load it is carrying and the road and traffic situation (gradients, road types, etc.), all relevant emissions (CO₂, air pollutants, greenhouse gases) are displayed
- Production of emissions reports for routes and trips
- Offsetting of CO₂ emissions possible with “myclimate”
- The only TÜV-certified emissions calculation worldwide
- Calculation of CO₂ emissions based on the french decree 2011-1336, according to which a CO₂ report has to be drawn up for all transports within, to and from France
- Possibility to calculate CO₂ also for subcontractors
- Calculation possible according to the new European standard for calculating fuel consumption and greenhouse gas emissions for transport services

It can also visualize customer data for instance data related to the delivery address (e.g. access to ramps, gates, etc.) and use it for route planning; import of customer data in different formats categorisation of addresses, e.g. as A, B and C customers, turnover potential, display of customer data with different colours and symbols, find service areas, hotels, etc. with the proximity search function.

4.1.3 Versions and interfaces

PTV Map& Guide is available in three different versions depending on the specific use case and technical environment:

- PTV Map&Guide desktop
Local, single-user installation on a workstation
- PTV Map&Guide intranet
On a Web server in the customers inhouse data processing centre
- PTV Map&Guide internet
Installation unnecessary, the product runs in the browser

4.2 PTV Smartour

4.2.1 Basics

PTV Smartour is a software solution which automatically plans orders to optimum trips and includes all restrictions which are relevant for the planner and the customers. This makes the software as individual as possible and it can be customised to workflow requirements, system environment and complex planning tasks. Many important functions in PTV Smartour support businesses in day to day planning tasks.

4.2.2 Features

PTV Smartour is a trip/ tour planning software solution for various transport and logistic use cases. It has a wide range of functionalities and features, uses high performance planning methods and algorithms to provide valid planning solutions with the possibility to enhance the results step by step considering all kinds of parameters and additional information which arise during planning and execution.

An overview of PTV Smartour 's functions:

- Planning combined multi-drop transports
- Daily trip planning for varying quantities and delivery points
- Multi-day trip planning
- Precombined trip planning and multi-depot planning
- Planning with sub depot trips
- Calculation of transport costs, toll charges and CO₂ emissions
- Integrated data supply
- Different vehicle profiles

- Assignment of orders to one or more task fields
- Order grouping
- Single user solution or multi-user system
- Suggestion functions
- Multi-users
- Different locations
- One database.

The trip planning software can be used at several workstations, but all users should access the same data. Several employees will need access to all task fields, but only some will have planning rights. PTV Smartour is suited to meet all those requirements. For example two or more dispatchers can share a planning area. This means orders from both employees are planned to the same resources (e.g., drivers and vehicles).

- Planning with mixed vehicle types in one software.

If depot-based transports are being planned as round trips, also long distance transports, i.e. ones without depots have to be coordinated. These transports can be displayed in one mutual plan. With the help of PTV Smartour a dispatcher can plan a combination of local and long-distance trips.

- Integrated data supply with all information relevant to transport.

Differing opening hours of incoming goods departments, limited clearance on customers' sites, "Tail lift required"; these information can easily be stored in PTV Smartour. A practical example: Opening hours Mon.04:00-12:00 and 14:00-18:00, Tues.-Thurs.7:00-16:00,Fri. 7:00-12:00. Storing this data in Smartour is standard, so the automatic trip planning can use these data.

- CO₂-calculation.

This is the foundation to day for one of tomorrow's priorities. The keyword here is "Green Logistics". Calculation of pollutant emissions, transfer of the data to other systems and further editing is possible. So there's nothing to get in the way of emission offsetting. To be used for example as proof on an invoice or delivery note. The use of this emissions data as the basis of offsetting can be the unique selling point apart from the rest with one of tomorrow's priorities today.

An intermodal planning application based on PTV Smartour is available as a prototype, can be accessed via webservice for research purposes and will be further developed in frame of the GET Service project with dedicated interfaces in order to provide planning solutions and to support the defined business cases.

5 A detailed description of JdR's TMS and APS

The central and decentral planning departments use the TMS for transport management and the APS for planning and execution. Jan de Rijk logistics is using for its TMS system an implementation of Kewill's TMS product "Chainware". For its planning and execution the APS system of Quintiq is being used. The Quintiq system works with modelled functionalities.

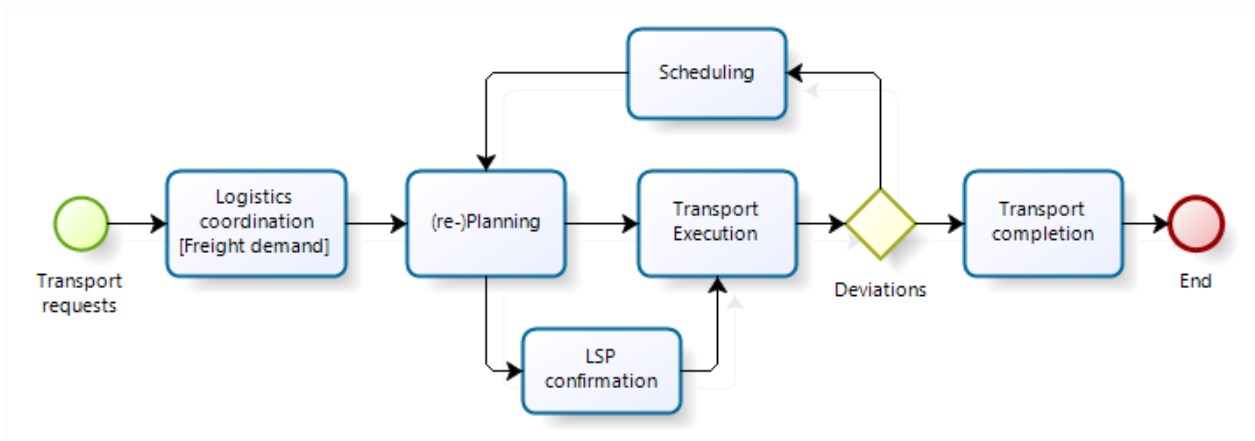


Figure 2: An overview of the planning system in JdR

5.1 General process

When a request for transport is being received the "Logistics Coordination" department, also called customer support, determines what type of cargo, how much in terms of volumes and weight, origin and destination, licenses, skills and what kind of modality is being requested.

For this description we focus on road transportation. This means that the request for transport should be divided into loads to be shipped via a truck. A request for transport, also called a transport booking is divided into one or multiple shipments. A shipment always fits into one truck. This process of order handling is being done completely with the functionalities of the TMS system. When all information is acknowledged the shipment is then being cleared for planning.

The APS system at Jan de Rijk logistics is being called the JPLEXS system; this is an abbreviation for the Jan de Rijk planning, execution and scheduling system. Based on the shipments created within the TMS, the planning departments will match the shipments with the available assets. An asset is a general term for a pulled unit (trailer), freight unit (container), driving unit and a driver. The shipment planner is looking at the available Trucks. A truck is a combination of assets. A truck is complete when a driver is assigned to the truck. When the shipment is planned on a truck and there are still shipments to be planned the shipment planner will combine assets or look for available charters. When a shipment is planned on a truck and the shipment planner releases the truck, the

asset planner will take over and start the execution. This means that the driver will be informed, the handling locations will be checked and informed and the customer will receive a notification (if requested via the SLA). During execution of the logistics activities like loading, driving, resting, co-loading, un-loading and the way bill control, the asset planner continuously is being informed via the real-time messaging system build into the APS. This messaging receives status updates from the on-board computer devices. When a charter is being used this way of messaging is not possible. Then the asset planner had to keep in contact via the phone.

When unloading has finished and the way bill documents (like a CMR) have been signed the shipment will be handled for completion. This means that the finance department will start the invoicing. Based on the SLA with the customer a weekly or a monthly performance report will be generated. A performance report generally consists of

- On time loading and unloading
- Waiting time
- KM's driven (effective and empty)

5.2 TMS

The Chainware TMS system is being used for all kind of day to day logistical operations. Jan de Rijk logistics uses these standard functionalities:

- Customer control
Information about the handling locations, contacts, logistics service levels, invoicing specifications.
- Order entry
create a transport booking and split into one or more shipments.
- Order control
Which planning department is handling the order.
- Invoicing
- Asset management
Type of assets, life time, maintenance, manufacturer.
- Driver management
Driver skills, training, licenses (like ADR for transporting dangerous goods).
- Document control
Way bills and CMR documents are being printed via the TMS system.

- Customs control
When freight is being exported a customs declaration is needed. For the dutch customs a MRN (movement reference number) is required.
- Activity based costing
Logistics activities (like loading, unloading, waiting, driving) are being calculated for costing purposes.
- Reporting
Performance reports are being derived from the information in the TMS.

5.3 APS

The APS environment from Quintiq has the ability to model a certain logistics plannings and execution process. This is what Jan de Rijk logistics has developed during the years into an Planning and Execution system called JPLEXS. The main functionalities of the APS system JPLEXS (see **Figure 3**) are:

- Shipments and Trips per location
 - o Based on the shipments from the TMS a selector creates visibilities per region across Europe. The planning departments can then quickly see and decide upon the transport capacity needed.
- Assets per location
 - o Based on the own fleet the APS system keeps track of every asset. Whether it's a freight unit, a pulled unit, a driving unit or a driver. This view informs the planner what assets are available at what time and where.
- Trucks per location
 - o A truck is a combination of assets. Therefore this functionality gives a good view on the available, realtime and operational (at execution level) capacity.
- Alerting
 - o This mechanism is based on events. An event can be a message from an on board computer device, or from a combination of assets or from a shipment with special transport requirements, or time related events (like the timing of logistics activities).
- Messaging
 - o Status messages about shipments are generated and sent automatically to the customer.
- Security
 - o Based on the geofencing functionality a trip can be controlled via a certain route.
- Charter management

- o This functionality handled charters. The logistics activities are visible and information about the status of the shipment.
- Reverse logistics
 - o Keeping track of empty equipment, containers, trolleys, etc.

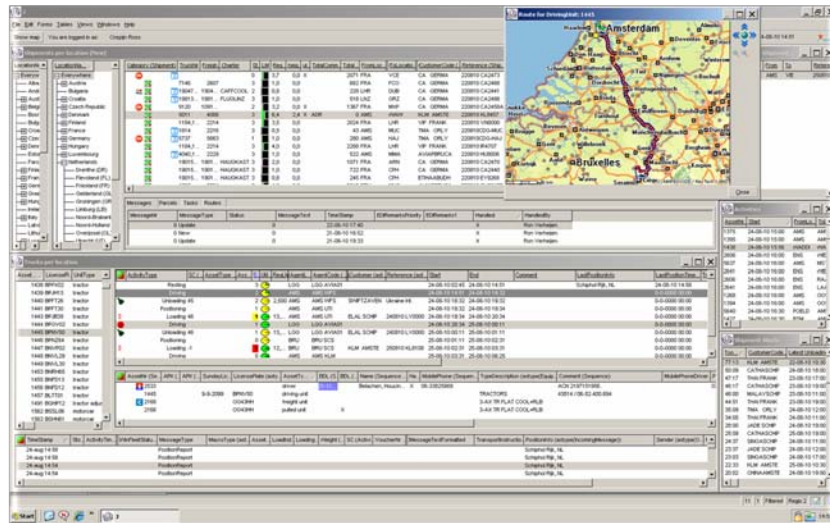


Figure 3: A screenshot of JDR's APS system

Note: for both the APS and the TMS systems JDR has built special functionalities. These are left out due to confidentiality purposes.

Figure 4 gives an overview of the base functionalities of the JPLEXS system:

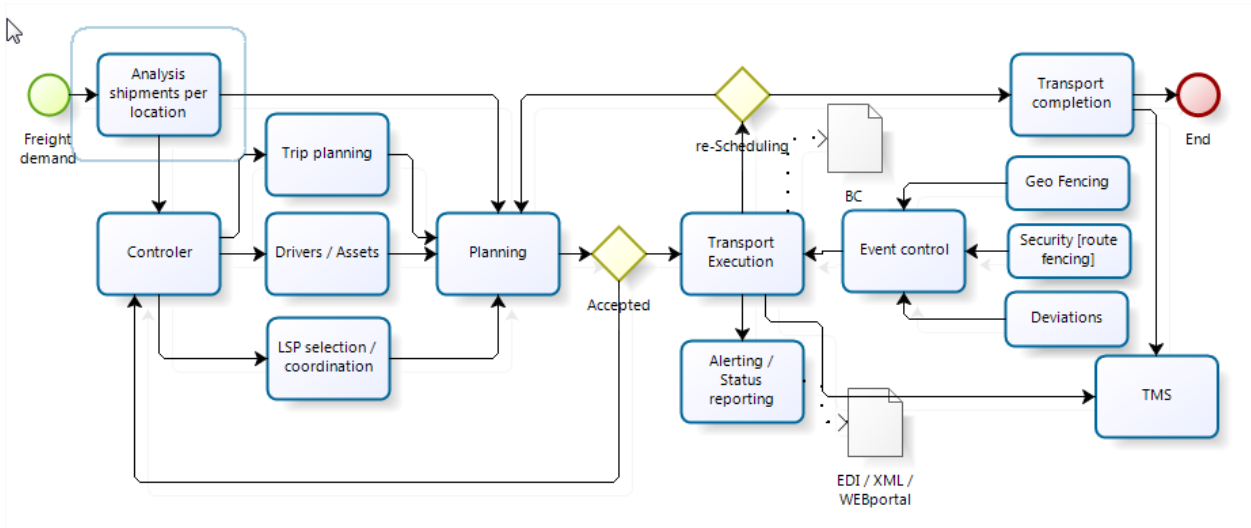


Figure 4: An overview of the base functionalities of the JPLEXS

6 Summary and Conclusions

This deliverable reviews and compares the available TMS software's in the market. Approximately 49 TMS solutions and four online freight platforms have been found by searching academic literature and online sources. In order to compare the available systems, the list of 10 dimensions has been created considering the most important features of these systems. All TMS software's are analysed and the strengths and weakness of each software packages are presented in the report. The main findings are summarized in this part of the report.

- ✓ Several groups (users) need TMS and it is therefore important to tailor the software based on the requirement of the user.
- ✓ Planning & Optimization, Execution, and Visibility & Performance Management are an important components of a standard TMS solutions.
- ✓ A new trend is offering TMS solutions as a shared software service over the Internet. This change is one of the most important requirements in the TMS market. Even though small companies can benefit more from this feature, larger companies are also showing an interest in this business model because it can mean less of an upfront investment.
- ✓ Network integration and sustainability are major developments that will continue to shape the market in the close future.
- ✓ Green awareness should be included in transport planning systems. It is therefore very important to measure the CO₂e emissions accurately.
- ✓ Mode selection, service network design, capacity management should be processed with transportation management system.
- ✓ A TMS is very focused on the planning and optimization of assets. In a lot of cases, this is completely centred on trucks, but some of the solutions have multimodal capabilities.
- ✓ GPS tracking devices must be installed on trucks as complementary equipment for the consistent communication during transportation.
- ✓ Systematic maintenance schedule of IT system must be constructed.
- ✓ The new developments should be followed to enhance the TMS software's.

In a conclusion, this report is a primary research to investigate how TMS software works and what we can get benefit of the current technology. These findings also show the need of such systems like GET Service project.

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Appendix: Survey

A study on different "planing tools" covered by software packages

1. Is the software package capable of performing Vehicle Routing and Scheduling? this includes:

a) whether the software is capable of considering Heterogeneous fleet requirements?

b) whether it is capable of performing Multi-depot distribution planning?

c) what type of data can it handle? i.e., use of Deterministic/Stochastic data(ability to handle uncertainty of data)

Please provide answers for the above questions in the space below

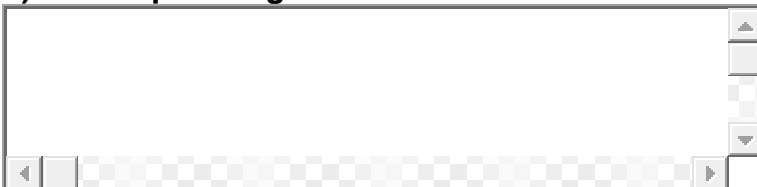


2. What is the type of planning supported by the software package?

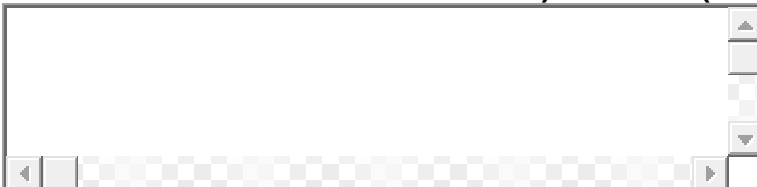
a) Online planning - wherein some data emerges as time progresses. also, how this facility is capitalized in carrying out "Re-planning"

OR

b) Offline planning - all data is known beforehand



3. What type of Optimization algorithms(those which provide exact solutions or those which make use of heuristics) is used? (Please name)



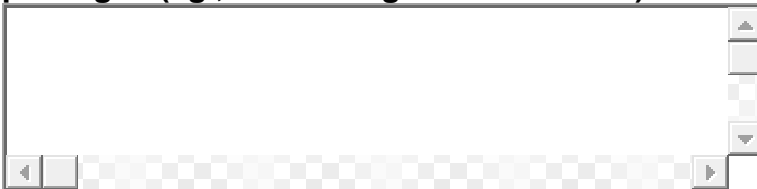
4. Is there an option to accommodate Inter-modal(multiple modes of transportation) trip planning?



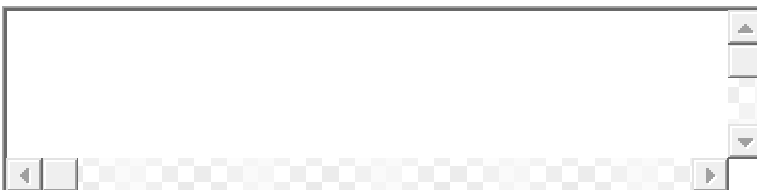
5. Is the software package capable of providing Multi-objective optimization? i.e., optimization of distance, cost, time and profit



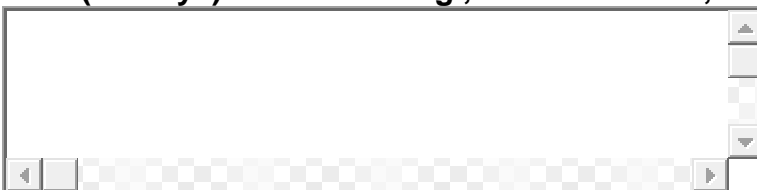
6. What extent of Green Logistics awareness is incorporated in the software package? (eg., calculating CO₂ emissions)



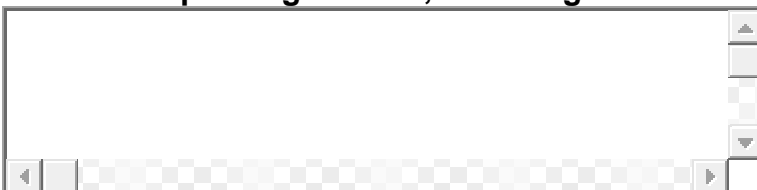
7. Is there a provision to include factors like congestion/time dependency in the model?



8. Is there a provision to use Synchromodal trip planning? (compared to intermodal(which is sequential), in synchromodal you plan freight from A to B via 2 or more(mostly2) modalities. e.g., train and truck, at the same time ; in parallel)




9. Does the software package possess event handling capabilities? i.e., being aware and making required changes based on events like road works/rail works, customs/import regulations, installing smart devices on trucks etc



10. a) Does the software package possess Message processing/integration capabilities?

b) Please provide the name of your organization.

A large empty rectangular box with a checkered border, intended for providing the organization name. The box is currently blank.