

# TMS-NAVITEL — Modelos de Datos, DTOs, Validaciones y Reglas de Negocio

**Complemento de:** [API\\_CONTRACT.md](#) (endpoints y rutas)

**Versión:** 1.0.0

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**Este documento contiene:** Modelos de BD, DTOs request/response, enums, máquinas de estado, validaciones, FKs y reglas de negocio

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## 1. Formato de respuestas estándar

ApiResponse<T>

```
{  
    success: boolean;           // Siempre presente  
    data: T;                   // El dato o lista de datos  
    message?: string;          // Mensaje de error o éxito  
    timestamp: string;         // ISO 8601  
}
```

## PaginatedResponse<T>

```
{
  items: T[];
  pagination: {
    page: number;           // 1-based
    pageSize: number;
    totalItems: number;
    totalPages: number;
    hasNext: boolean;
    hasPrevious: boolean;
  }
}
```

## PaginationParams (query string)

```
?page=1&pageSize=20&sortBy=createdAt&sortOrder=desc
```

## SearchParams (query string)

```
?search=texto&status=active&page=1&pageSize=20
```

## 2. Entidades base y tipos comunes

### BaseEntity (todos las entidades heredan estos campos)

Campo	Tipo	Requerido	Notas
id	string (UUID)	Auto	PK generado por backend
createdAt	string (ISO 8601)	Auto	Timestamp de creación
updatedAt	string (ISO 8601)	Auto	Timestamp de última modificación

### AuditableEntity (extiende BaseEntity)

Campo	Tipo	Notas
createdBy	string	ID del usuario que creó
updatedBy	string	ID del usuario que modificó

### ActivatableEntity (extiende BaseEntity)

Campo	Tipo	Notas
status	EntityStatus	Ver enum abajo
isEnabled	boolean	Flag de habilitación

## Enums comunes

```
EntityStatus = "active" | "inactive" | "pending" | "blocked" | "suspended" |
"on_leave" | "terminated"
DocumentStatus = "valid" | "expired" | "pending" | "missing"
```

## RequiredDocument

Campo	Tipo	Req	Notas
id	string	Sí	
name	string	Sí	Nombre del documento
description	string	No	
isRequired	boolean	Sí	Si es obligatorio
status	DocumentStatus	Sí	
expirationDate	string	No	ISO 8601
fileUrl	string	No	URL del archivo

## ValidationChecklist

Campo	Tipo	Notas
entityId	string	FK → entidad evaluada
entityType	"driver" \  "vehicle" \  "operator"	
documents	RequiredDocument[]	Lista de documentos
isComplete	boolean	Todos los requeridos OK
completionPercentage	number	0-100

## ImportResult / ExportOptions

```
ImportResult {
  totalRows: number;
  successCount: number;
  errorCount: number;
  errors: { row: number; field: string; message: string; value?: string }[];
}
```

```
ExportOptions {
    format: "xlsx" | "csv";
    columns?: string[];
    filters?: Record<string, unknown>;
}
```

### 3. Customer (Cliente)

#### Enums

```
CustomerType      = "empresa" | "persona"
DocumentType     = "RUC" | "DNI" | "CE" | "PASSPORT"
CustomerCategory = "standard" | "premium" | "vip" | "wholesale"
PaymentTerms     = "immediate" | "15_days" | "30_days" | "45_days" | "60_days"
```

#### Customer (extiende BaseEntity)

Campo	Tipo	Req	FK	Notas
code	string	No		Código auto-generado
type	CustomerType	Sí		
documentType	DocumentType	Sí		
documentNumber	string	Sí		Único, validar formato
name	string	Sí		Razón social o nombre
tradeName	string	No		Nombre comercial
email	string	Sí		Email válido
phone	string	Sí		
phone2	string	No		
website	string	No		
status	EntityStatus	Sí		
category	CustomerCategory	No		
addresses	CustomerAddress[]	Sí		Al menos 1
contacts	CustomerContact[]	Sí		
creditLimit	number	No		Monto máximo
creditUsed	number	No		Crédito utilizado
billingConfig	CustomerBillingConfig	No		

Campo	Tipo	Req	FK	Notas
operationalStats	CustomerOperationalStats	No		Calculado
notes	string	No		
tags	string[]	No		
industry	string	No		
firstOrderDate	string	No		
preferredWorkflowId	string	No		→ Workflow

### CustomerAddress

Campo	Tipo	Req
id	string	Sí
type	"billing" \  "shipping" \  "main" \  "branch"	Sí
label	string	No
address	string	Sí
district	string	No
province	string	No
department	string	No
country	string	Sí
postalCode	string	No
coordinates	{ lat: number; lng: number }	No
geofenceId	string	No → Geofence
isDefault	boolean	Sí

### CustomerBillingConfig

Campo	Tipo
paymentTerms	PaymentTerms
defaultCurrency	string
taxId	string
invoiceEmail	string
invoicePrefix	string
requirePO	boolean

## CreateCustomerDTO

```
// Omite: id, createdAt, updatedAt, operationalStats, firstOrderDate, creditUsed
{
  type: CustomerType;                      // Requerido
  documentType: DocumentType;              // Requerido
  documentNumber: string;                  // Requerido, validar
  name: string;                           // Requerido
  tradeName?: string;
  email: string;                          // Requerido, email válido
  phone: string;                          // Requerido
  status?: EntityStatus;                  // Default: "active"
  category?: CustomerCategory;
  addresses: CustomerAddress[];          // Al menos 1
  contacts?: CustomerContact[];
  creditLimit?: number;
  billingConfig?: CustomerBillingConfig;
  preferredWorkflowId?: string;
  notes?: string;
  tags?: string[];
}
```

## 4. Driver (Conductor)

### Enums

```
LicenseCategory      = "A-I" | "A-IIa" | "A-IIb" | "A-IIIa" | "A-IIIb" | "A-IIIc"
DriverStatus         = "active" | "inactive" | "suspended" | "on_leave" |
"terminated"
DriverAvailability   = "available" | "on-route" | "resting" | "vacation" | "sick-
leave" | "suspended" | "unavailable"
DriverDocumentType   = "DNI" | "CE" | "PASSPORT"
BloodType            = "A+" | "A-" | "B+" | "B-" | "AB+" | "AB-" | "O+" | "O-"
MedicalExamType     = "pre_employment" | "periodic" | "post_incident" |
{return_to_work} | "exit"
ExamResult           = "approved" | "conditional" | "rejected" | "pending"
CertificationType   = "matpel" | "sst_induction" | "sst_annual" |
"defensive_driving" | "first_aid" | "fire_safety" | "cold_chain" |
"hazmat_awareness" | "customer_service" | "gps_tracking" | "load_securing" |
"other"
IncidentType         = "accident" | "trafficViolation" | "cargo_damage" |
"customer_complaint" | "mechanical_issue" | "safetyViolation" | "documentation" |
"other"
```

Driver (extiende ActivatableEntity) — ~60 campos

Campo	Tipo	Req	FK	Notas
-------	------	-----	----	-------

Campo	Tipo	Req	FK	Notas
code	string	Sí		3-20 chars
documentType	DriverDocumentType	Sí		
documentNumber	string	Sí		Validar por tipo
firstName	string	Sí		2-50
lastName	string	Sí		2-50
motherLastName	string	No		
fullName	string	Sí		Computed server-side
email	string	Sí		Email válido
phone	string	Sí		Regex: ^\+?[0-9\s-]{9,15}\$
alternativePhone	string	No		
birthDate	string	Sí		Edad 18-70
birthPlace	string	No		
nationality	string	Sí		Default: "Peruana"
bloodType	BloodType	No		
address	string	Sí		10-200 chars
district	string	No		
province	string	No		
department	string	No		
license	DriverLicense	Sí		Ver sub-modelo
emergencyContact	EmergencyContact	Sí		
additionalEmergencyContacts	EmergencyContact[]	No		
availability	DriverAvailability	Sí		
unavailabilityReason	string	No		Si no disponible
expectedReturnDate	string	No		
currentMedicalExam	MedicalExam	No		Vigente
medicalExamHistory	MedicalExam[]	Sí		
currentPsychologicalExam	PsychologicalExam	No		
psychologicalExamHistory	PsychologicalExam[]	Sí		

Campo	Tipo	Req	FK	Notas
certifications	TrainingCertification[]	Sí		
policeRecord	PoliceRecord	No		
criminalRecord	CriminalRecord	No		
drivingRecord	DrivingRecord	No		
drivingLimits	DrivingLimits	Sí		Ver validación HOS
currentWeekHours	WeeklyHoursSummary	No		Calculado
incidents	DriverIncident[]	Sí		
performanceMetrics	DriverPerformanceMetrics	No		Calculado
hireDate	string	Sí		
terminationDate	string	No		
operatorId	string	No	→ Operator	
operatorName	string	No		Denormalizado
assignedVehicleId	string	No	→ Vehicle	
assignedVehiclePlate	string	No		Denormalizado
status	DriverStatus	Sí		
checklist	ValidationChecklist	Sí		Calculado
documents	RequiredDocument[]	Sí		
photoUrl	string	No		URL
signatureUrl	string	No		URL
notes	string	No		Max 1000
tags	string[]	No		

## DriverLicense

Campo	Tipo	Req	Validación
number	string	Sí	Regex: ^[A-Z]\d{8}\$
category	LicenseCategory	Sí	Enum
issueDate	string	Sí	No puede ser futura
expiryDate	string	Sí	

Campo	Tipo	Req	Validación
issuingAuthority	string	Sí	Min 3 chars
issuingCountry	string	Sí	Default: "Perú"
points	number	Sí	0-100
maxPoints	number	Sí	Default: 100
restrictions	LicenseRestrictions	Sí	
fileUrl	string	No	URL
verificationStatus	"pending" \  "verified" \ \ "rejected"	Sí	
lastVerificationDate	string	No	

## LicenseRestrictions

```
{
  requiresGlasses: boolean;      // Default: false
  requiresHearingAid: boolean;   // Default: false
  automaticOnly: boolean;        // Default: false
  otherRestrictions?: string[];
}
```

## EmergencyContact

Campo	Tipo	Req
name	string	Sí (3-100)
relationship	"spouse" \  "parent" \  "sibling" \  "child" \ \ "friend" \  "other"	Sí
relationshipDetail	string	No
phone	string	Sí (regex tel)
alternativePhone	string	No
address	string	No

## MedicalExam

Campo	Tipo	Req
id	string	Sí
type	MedicalExamType	Sí

Campo	Tipo	Req
date	string	Sí
expiryDate	string	Sí
result	ExamResult	Sí
restrictions	MedicalRestriction[]	Sí
clinicName	string	Sí (min 3)
clinicRuc	string	No (11 dígitos)
doctorName	string	Sí (min 3)
doctorCmp	string	No
certificateNumber	string	Sí (min 3)
fileUrl	string	No
observations	string	No

## DrivingLimits

Campo	Tipo	Default
maxHoursPerDay	number	8 (min 1, max 12)
maxHoursPerWeek	number	48 (min 1, max 60)
restRequiredAfterHours	number	4 (min 1, max 8)
minRestDuration	number	0.5 (min 0.5, max 12)
nightDrivingAllowed	boolean	true
nightStartTime	string	Opcional
nightEndTime	string	Opcional

## 5. Vehicle (Vehículo)

### Enums

```

VehicleType          = "camion" | "tractocamion" | "remolque" | "semiremolque"
| "furgoneta" | "pickup" | "minivan" | "cisterna" | "volquete"
BodyType            = "furgon" | "furgon_frigorifico" | "plataforma" |
"cisterna" | "tolva" | "volquete" | "portacontenedor" | "cama_baja" | "jaula" |
"baranda" | "otros"
VehicleOperationalStatus = "available" | "on-route" | "loading" | "unloading" |
"maintenance" | "repair" | "inspection" | "standby" | "inactive" | "operational" |
"in_transit" | "parked" | "in_maintenance" | "out_of_service"
VehicleStatus        = "active" | "inactive" | "maintenance" | "retired"

```

```

FuelType          = "diesel" | "gasoline" | "gas_glp" | "gas_gnv" |
"electric" | "hybrid"
TransmissionType = "manual" | "automatic" | "semi_automatic"
InsuranceType    = "soat" | "rc_obligatorio" | "rc_complementario" |
"full_coverage" | "cargo_insurance" | "theft_insurance"
InspectionResult = "approved" | "observations" | "rejected"
MaintenanceType  = "preventive" | "corrective" | "inspection" |
"emergency" | "recall" | "upgrade"
MaintenanceStatus = "scheduled" | "in_progress" | "completed" | "cancelled" |
"overdue"

```

Vehicle (extiende ActivatableEntity) — ~50 campos

Campo	Tipo	Req	FK
code	string	Sí (3-20)	
plate	string	Sí	
trailerPlate	string	No	
type	VehicleType	Sí	
bodyType	BodyType	Sí	
mtcCategory	string	No	
specs	VehicleSpecs	Sí	
dimensions	VehicleDimensions	No	
capacity	VehicleCapacity	Sí	
registration	VehicleRegistration	Sí	
insurancePolicies	InsurancePolicy[]	Sí	
currentInspection	TechnicalInspection	No	
inspectionHistory	TechnicalInspection[]	Sí	
operatingCertificate	OperatingCertificate	No	
gpsDevice	GPSDevice	No	
lastLocation	VehicleLocation	No	
operationalStatus	VehicleOperationalStatus	Sí	
currentMileage	number	Sí	≥ 0
nextMaintenanceDate	string	No	
nextMaintenanceMileage	number	No	
maintenanceHistory	MaintenanceRecord[]	Sí	
maintenanceSchedules	MaintenanceSchedule[]	Sí	

Campo	Tipo	Req	FK
fuelHistory	FuelRecord[]	Sí	
currentFuelEfficiency	number	No	
incidents	VehicleIncident[]	Sí	
certifications	VehicleCertification[]	Sí	
performanceMetrics	VehiclePerformanceMetrics	No	Calc
operatorId	string	No	→ Operator
operatorName	string	No	
currentDriverId	string	No	→ Driver
currentDriverName	string	No	
checklist	ValidationChecklist	Sí	
documents	RequiredDocument[]	Sí	
photos	string[]	No	
notes	string	No	Max 1000
tags	string[]	No	

## VehicleSpecs

Campo	Tipo	Validación
brand	string	2-50
model	string	1-50
year	number	1990 - año actual+1
color	string	2-30
engineNumber	string	5-30
chassisNumber	string	Exactamente 17, regex VIN: [A-HJ-NPR-Z0-9]{17}
serialNumber	string	Opcional
axles	number	2-10
wheels	number	4-24
fuelType	FuelType	Enum
fuelTankCapacity	number	10-500 galones
transmission	TransmissionType	Enum
engineDisplacement	number	Opcional, > 0

Campo	Tipo	Validación
horsepower	number	Opcional, > 0
<b>VehicleCapacity</b>		
Campo	Tipo	Validación
grossWeight	number	> 0 (kg)
tareWeight	number	> 0 (kg)
maxPayload	number	> 0 (kg), ≤ <b>grossWeight</b> - <b>tareWeight</b>
maxVolume	number	Opcional, > 0 (m³)
palletCapacity	number	Opcional, entero > 0
<b>InsurancePolicy</b>		
Campo	Tipo	Validación
type	InsuranceType	Enum
policyNumber	string	Min 5
insurerName	string	Min 3
insurerRuc	string	11 dígitos
startDate	string	
endDate	string	> <b>startDate</b>
coverageAmount	number	> 0
currency	"PEN" \  "USD"	
verificationStatus	"pending" \  "verified" \  "rejected"	
<b>GPSDevice</b>		
Campo	Tipo	Validación
deviceId	string	Min 5
imei	string	Exactamente 15 dígitos
simNumber	string	Opcional
provider	string	Min 3
model	string	Min 2
installationDate	string	

Campo	Tipo	Validación
certificationExpiry	string	
homologationNumber	string	Min 5
status	"active" \  "inactive" \  "malfunction" \      "removed"	

Formato de placa peruana

```
^[A-Z]{3}-\d{3}$      // ABC-123
^[A-Z]\d[A-Z]-\d{3}$ // A1B-234
^[A-Z]{2}\d-\d{3}$   // AB1-234
```

## 6. Operator (Operador)

Enums

```
OperatorType = "propio" | "tercero" | "asociado"
OperatorStatus = "enabled" | "blocked" | "pending"
```

Operator (extiende BaseEntity)

Campo	Tipo	Req
code	string	Sí
ruc	string	Sí (11 dígitos, validar mod 11)
businessName	string	Sí
tradeName	string	No
type	OperatorType	Sí
email	string	Sí
phone	string	Sí
fiscalAddress	string	Sí
contacts	OperatorContact[]	Sí
checklist	OperatorValidationChecklist	Sí
documents	OperatorDocument[]	Sí
driversCount	number	Sí
vehiclesCount	number	Sí

Campo	Tipo	Req
contractStartDate	string	No
contractEndDate	string	No
notes	string	No
status	OperatorStatus	Sí

## 7. Product (Producto)

### Enums

```
ProductCategory = "general" | "perecible" | "peligroso" | "fragil" | "refrigerado"
| "congelado" | "granel"
UnitOfMeasure   = "kg" | "ton" | "lt" | "m3" | "unit" | "pallet" | "container"
```

### Product (extiende BaseEntity)

Campo	Tipo	Req	FK
sku	string	Sí	Único
name	string	Sí	
description	string	No	
category	ProductCategory	Sí	
unitOfMeasure	UnitOfMeasure	Sí	
dimensions	ProductDimensions	No	
transportConditions	TransportConditions	Sí	
status	EntityStatus	Sí	
barcode	string	No	
unitPrice	number	No	
imageUrl	string	No	
customerId	string	No	→ Customer
notes	string	No	

### TransportConditions

```
{
  requiresRefrigeration: boolean;
  temperatureRange?: { min: number; max: number; unit: "celsius" | "fahrenheit" };
}
```

```

    requiresHazmatHandling: boolean;
    hazmatClass?: string;
    stackable: boolean;
    maxStackLayers?: number;
    fragile: boolean;
    specialInstructions?: string;
}

```

## 8. Geofence (Geocerca)

### Enums

```

GeofenceType      = "polygon" | "circle" | "corridor"
GeofenceCategory = "warehouse" | "customer" | "plant" | "port" | "checkpoint" |
"restricted" | "delivery" | "other"

```

### Geofence (extiende BaseEntity)

Campo	Tipo	Req	FK
code	string	Sí	
name	string	Sí	
description	string	No	
type	GeofenceType	Sí	
category	GeofenceCategory	Sí	
geometry	GeofenceGeometry	Sí	Union type
tags	GeofenceTag[]	Sí	
alerts	GeofenceAlerts	Sí	
status	EntityStatus	Sí	
color	string	Sí	Hex
opacity	number	Sí	0-1
address	string	No	
customerId	string	No	→ Customer
notes	string	No	

### GeofenceGeometry (union type)

```
// Polígono
{ type: "polygon"; coordinates: { lat: number; lng: number }[] }

// Círculo
{ type: "circle"; center: { lat: number; lng: number }; radius: number }

// Corredor
{ type: "corridor"; path: { lat: number; lng: number }[]; width: number }
```

## 9. Order (Orden)

### Enums

```
OrderStatus      = "draft" | "pending" | "assigned" | "in_transit" | "at_milestone"
| "delayed" | "completed" | "closed" | "cancelled"
OrderSyncStatus = "not_sent" | "pending" | "sending" | "sent" | "error" | "retry"
MilestoneStatus = "pending" | "approaching" | "arrived" | "in_progress" |
"completed" | "skipped" | "delayed"
OrderPriority    = "low" | "normal" | "high" | "urgent"
CargoType        = "general" | "refrigerated" | "hazardous" | "fragile" |
"oversized" | "liquid" | "bulk"
```

Order — ~40 campos

Campo	Tipo	Req	FK
id	string	Auto	PK
orderNumber	string	Auto	Único, visible
customerId	string	Sí	→ Customer
customer	Pick<Customer>	No	Populated
carrierId	string	No	→ Operator
carrierName	string	No	
vehicleId	string	No	→ Vehicle
vehicle	{ id, plate, brand, model, type }	No	Populated
driverId	string	No	→ Driver
driver	Pick<Driver>	No	Populated
gpsOperatorId	string	No	→ Operator
workflowId	string	No	→ Workflow
workflowName	string	No	

Campo	Tipo	Req	FK
status	OrderStatus	Sí	Default: "draft"
priority	OrderPriority	Sí	
syncStatus	OrderSyncStatus	Sí	Default: "not_sent"
syncErrorMessage	string	No	
lastSyncAttempt	string	No	
cargo	OrderCargo	Sí	Ver abajo
milestones	OrderMilestone[]	Sí	
completionPercentage	number	Sí	0-100, calculado
scheduledStartDate	string	Sí	
scheduledEndDate	string	Sí	
actualStartDate	string	No	
actualEndDate	string	No	
closureData	OrderClosureData	No	Solo si cerrada
statusHistory	OrderStatusHistory[]	Sí	
externalReference	string	No	Ref del cliente
notes	string	No	
tags	string[]	No	
metadata	Record<string, unknown>	No	
createdBy	string	Sí	
createdAt	string	Auto	
updatedAt	string	Auto	

## OrderCargo

Campo	Tipo	Req
description	string	Sí
type	CargoType	Sí
weightKg	number	Sí
volumeM3	number	No
quantity	number	Sí
declaredValue	number	No

Campo	Tipo	Req
temperatureControlled	boolean	No
temperatureRange	{ min, max, unit }	No
handlingInstructions	string	No

### OrderMilestone

Campo	Tipo	Req	FK
id	string	Auto	
orderId	string	Sí	→ Order
geofenceId	string	Sí	→ Geofence
geofenceName	string	Sí	
type	"origin" \  "waypoint" \ \ "destination"	Sí	
sequence	number	Sí	
address	string	Sí	
coordinates	{ lat, lng }	Sí	
estimatedArrival	string	Sí	
estimatedDeparture	string	No	
actualEntry	string	No	
actualExit	string	No	
status	MilestoneStatus	Sí	Default: "pending"
delayMinutes	number	No	+ = retraso, - = adelanto
notes	string	No	
contact	{ name, phone, email? }	No	

### OrderClosureData

Campo	Tipo	Req
observations	string	Sí
incidents	OrderIncidentRecord[]	Sí
deviationReasons	DeviationReason[]	Sí
closedBy	string	Sí

Campo	Tipo	Req
closedByName	string	Sí
closedAt	string	Sí
signature	string	No
attachments	OrderAttachment[]	No

## CreateOrderDTO

```
{
  customerId: string;           // Requerido
  carrierId?: string;
  vehicleId?: string;
  driverId?: string;
  workflowId?: string;
  priority: OrderPriority;      // Requerido
  cargo: OrderCargo;            // Requerido
  milestones: Omit<OrderMilestone, 'id' | 'orderId' | 'status' | 'actualEntry' | 
  'actualExit' | 'delayMinutes'>[];
  scheduledStartDate: string;    // Requerido
  scheduledEndDate: string;      // Requerido
  externalReference?: string;
  notes?: string;
  tags?: string[];
}
```

## OrderFilters (query params)

```
?search=ORD-001
&customerId=cust-001
&carrierId=op-001
&status=pending,assigned      // Acepta múltiples
&priority=high,urgent
&syncStatus=error
&dateFrom=2026-01-01
&dateTo=2026-01-31
&tags=urgente
&sortBy=createdAt
&sortOrder=desc
&page=1
&pageSize=20
```

## OrdersResponse

```
{
  data: Order[];
  total: number;
  page: number;
  pageSize: number;
  totalPages: number;
  statusCounts: Record<OrderStatus, number>; // Conteo por cada estado
}
```

## 10. Workflow

### Enums

```
WorkflowStatus      = "active" | "inactive" | "draft"
WorkflowStepAction = "enter_geofence" | "exit_geofence" | "manual_check" |
"document_upload" | "signature" | "photo_capture" | "temperature_check" |
"weight_check" | "custom"
WorkflowConditionType = "time_elapsed" | "time_window" | "location_reached" |
"document_uploaded" | "approval_received" | "manual_trigger" | "always"
NotificationType     = "email" | "sms" | "push" | "webhook" | "in_app"
```

### Workflow

Campo	Tipo	Req	FK
id	string	Auto	
name	string	Sí	
description	string	Sí	
code	string	Sí	Único
status	WorkflowStatus	Sí	
version	number	Sí	
steps	WorkflowStep[]	Sí	
escalationRules	EscalationRule[]	Sí	
applicableCargoTypes	string[]	No	
applicableCustomerIds	string[]	No	→ Customer[]
applicableCarrierIds	string[]	No	→ Operator[]
isDefault	boolean	Sí	
createdBy	string	Sí	

Campo	Tipo	Req	FK
updatedBy	string	Sí	

## WorkflowStep

Campo	Tipo	Req
id	string	Sí
name	string	Sí
description	string	No
sequence	number	Sí
action	WorkflowStepAction	Sí
isRequired	boolean	Sí
canSkip	boolean	Sí
actionConfig.geofenceId	string	No → Geofence
actionConfig.customFields	WorkflowCustomField[]	No
estimatedDurationMinutes	number	No
maxDurationMinutes	number	No
transitionConditions	WorkflowCondition[]	Sí
notifications	WorkflowNotification[]	Sí

## EscalationRule

```
{
  id: string;
  name: string;
  condition: {
    type: "delay_threshold" | "step_stuck" | "no_update";
    thresholdMinutes: number;
    stepIds?: string[];
  };
  actions: Array<{
    type: "notify" | "reassign" | "flag" | "auto_close";
    config: { ... };
  }>;
  isActive: boolean;
}
```

## WorkflowProgress (respuesta calculada)

Campo	Tipo
workflowId	string → Workflow
orderId	string → Order
currentStepId	string
currentStepIndex	number
totalSteps	number
completedSteps	string[]
skippedSteps	string[]
progressPercentage	number 0-100
timeInCurrentStep	number minutos
isDelayed	boolean

## 11. Incident (Incidencia)

### Enums

```

IncidentCategory = "vehicle" | "cargo" | "driver" | "route" | "customer" |
"weather" | "security" | "documentation" | "other"
IncidentSeverity = "low" | "medium" | "high" | "critical"
IncidentStatus   = "active" | "inactive" // Solo para catálogo

```

### IncidentCatalogItem

Campo	Tipo	Req
id	string	Auto
code	string	Sí
name	string	Sí
description	string	Sí
category	IncidentCategory	Sí
defaultSeverity	IncidentSeverity	Sí
requiresEvidence	boolean	Sí
acceptedEvidenceTypes	("photo" \  "document" \  "video")[]	No
minEvidenceCount	number	No
requiresImmediateAction	boolean	Sí

Campo	Tipo	Req
suggestedActions	string[]	No
descriptionTemplate	string	No
additionalFields	IncidentAdditionalField[]	No
affectsCompliance	boolean	Sí
autoNotifyRoles	string[]	No
status	IncidentStatus	Sí
sortOrder	number	Sí
tags	string[]	No

IncidentRecord (instancia en una orden)

Campo	Tipo	Req	FK
id	string	Auto	
orderId	string	Sí	→ Order
catalogItemId	string \  null	Sí	→ IncidentCatalogItem
type	"catalog" \  "free_text"	Sí	
name	string	Sí	
description	string	Sí	
category	IncidentCategory	Sí	
severity	IncidentSeverity	Sí	
occurredAt	string	Sí	
milestoneId	string	No	→ OrderMilestone
location	{ lat, lng, address? }	No	
actionTaken	string	Sí	
resolutionStatus	"pending" \  "in_progress" \  "resolved" \  "unresolved"	Sí	
resolvedAt	string	No	
resolvedBy	string	No	
evidence	IncidentEvidence[]	Sí	
reportedBy	string	Sí	
reportedAt	string	Sí	

## 12. Scheduling (Programación)

### Enums

```

ScheduleStatus = "unscheduled" | "scheduled" | "partial" | "ready" |
"in_progress" | "completed" | "conflict" | "cancelled"
ConflictType = "vehicle_overlap" | "driver_overlap" | "driver_hos" |
"vehicle_maintenance" | "driver_unavailable" | "capacity_exceeded" |
"license_expired" | "no_resource"
ConflictSeverity = "low" | "medium" | "high"

```

### ScheduleOrderPayload (POST /operations/scheduling/assign)

```

{
  orderId: string;
  scheduledDate: string;           // YYYY-MM-DD
  scheduledStartTime: string;       // HH:mm
  vehicleId?: string;
  driverId?: string;
  notes?: string;
}

```

### ScheduleConflict (respuesta)

Campo	Tipo
id	string
type	ConflictType
severity	ConflictSeverity
message	string
suggestedResolution	string
affectedEntity	{ type, id, name }
relatedOrderIds	string[]

### HOSValidationResult

```

{
  isValid: boolean;
  remainingHoursToday: number;
  weeklyHoursUsed: number;
  violations: string[];
}

```

```

    warnings?: string[];
}

```

## SchedulingKPIs

```
{
  pendingOrders: number;
  scheduledToday: number;
  atRiskOrders: number;
  fleetUtilization: number;           // 0-100%
  driverUtilization: number;          // 0-100%
  onTimeDeliveryRate: number;         // 0-100%
  averageLeadTime: number;            // Horas
  weeklyTrend: number;                // % cambio
}
```

## 13. Finance (Finanzas)

### Enums

```

InvoiceStatus = "draft" | "pending" | "sent" | "partial" | "paid" | "overdue" |
"cancelled" | "disputed"
InvoiceType    = "service" | "freight" | "accessorial" | "fuel" | "credit" |
"debit"
PaymentMethod  = "cash" | "bank_transfer" | "check" | "credit_card" | "debit_card" |
"credit" | "other"
PaymentStatus   = "pending" | "processing" | "completed" | "failed" | "refunded" |
"cancelled"
CostType       = "fuel" | "toll" | "maintenance" | "insurance" | "labor" |
"depreciation" | "administrative" | "accessorial" | "penalty" | "other"
RateCategory   = "weight" | "volume" | "distance" | "flat" | "hourly" | "package" |
"pallet" | "custom"

```

### Invoice — Campos clave

Campo	Tipo	FK
invoiceNumber	string	Único, auto-generado
type	InvoiceType	
status	InvoiceStatus	
customerId	string	→ Customer
issueDate	string	
dueDate	string	

Campo	Tipo	FK
currency	string	
subtotal	number	
taxTotal	number	
discountTotal	number	
total	number	
amountPaid	number	
amountDue	number	Calculado: total - amountPaid
lineItems	InvoiceLineItem[]	
taxes	TaxDetail[]	
orderIds	string[]	→ Order[]
relatedInvoiceId	string	→ Invoice (notas crédito)

## InvoiceLineItem

Campo	Tipo
description	string
quantity	number
unitPrice	number
unit	string
taxRate	number
discount	number
discountType	"percentage" \  "fixed"
orderId	string → Order
orderNumber	string

## Payment

Campo	Tipo	FK
paymentNumber	string	Único
invoiceId	string	→ Invoice
customerId	string	→ Customer
amount	number	

Campo	Tipo	FK
method	PaymentMethod	
status	PaymentStatus	
paymentDate	string	
referenceNumber	string	

## TransportCost

Campo	Tipo	FK
type	CostType	
amount	number	
orderId	string	→ Order
vehicleId	string	→ Vehicle
driverId	string	→ Driver
isReimbursable	boolean	
isApproved	boolean	
approvedBy	string	

## ServiceRate (Tarifas)

Campo	Tipo	FK
code	string	Único
category	RateCategory	
baseRate	number	
ranges	{ from, to, rate }[]	Escalonadas
customerId	string	→ Customer
vehicleType	string	
effectiveFrom	string	
effectiveTo	string	
isActive	boolean	
taxInclusive	boolean	

## CreateInvoiceDTO

```
{
  type: InvoiceType;
  customerId: string;
  dueDate: string;
  lineItems: Array<{
    description: string;
    quantity: number;
    unitPrice: number;
    unit: string;
    taxRate: number;
    discount: number;
    discountType: "percentage" | "fixed";
    orderId?: string;
  }>;
  orderIds?: string[];
  purchaseOrderNumber?: string;
  notes?: string;
}
```

## AccountsReceivableAging (respuesta)

```
{
  current: number;           // No vencido
  days1to30: number;         // 1-30 días vencido
  days31to60: number;
  days61to90: number;
  over90Days: number;
  total: number;
  byCustomer?: Array<{ customerId, customerName, current, days1to30, ... }>;
}
```

## 14. Monitoring (Monitoreo)

### Enums

```
MovementStatus      = "moving" | "stopped"
RetransmissionStatus = "online" | "temporary_loss" | "disconnected"
PlaybackSpeed       = 1 | 2 | 4 | 8 | 16 | 32
```

### RetransmissionRecord

Campo	Tipo	FK
vehicleId	string	→ Vehicle
vehiclePlate	string	

Campo	Tipo	FK
companyName	string	
gpsCompanyId	string	→ GpsCompany
gpsCompanyName	string	
lastConnection	string	ISO 8601
movementStatus	MovementStatus	
retransmissionStatus	RetransmissionStatus	
disconnectedDuration	number	Segundos
comments	string	
lastLocation	{ lat, lng }	
speed	number	km/h

## TrackedVehicle

Campo	Tipo	FK
id/plate	string	→ Vehicle
type	string	
position	VehiclePosition	
movementStatus	MovementStatus	
connectionStatus	RetransmissionStatus	
driverId	string	→ Driver
activeOrderId	string	→ Order

## VehiclePosition

```
{
  lat: number;
  lng: number;
  speed: number;           // km/h
  heading: number;         // 0-360 grados
  timestamp: string;
  accuracy?: number;       // Metros
  altitude?: number;       // Metros
}
```

## HistoricalRoute

Campo	Tipo
vehicleId	string → Vehicle
startDate	string
endDate	string
points	HistoricalRoutePoint[]
stats	HistoricalRouteStats

## HistoricalRoutePoint

```
{
  index: number;
  lat: number;
  lng: number;
  speed: number;
  heading: number;
  timestamp: string;
  isStopped: boolean;
  stopDuration?: number;           // Segundos
  distanceFromStart: number;       // km
  event?: {
    type: "geofence_enter" | "geofence_exit" | "stop_start" | "stop_end" |
    "speed_alert" | "ignition_on" | "ignition_off";
    description: string;
  }
}
```

## HistoricalRouteStats

```
{
  totalDistanceKm: number;
  maxSpeedKmh: number;
  avgSpeedKmh: number;
  movingTimeSeconds: number;
  stoppedTimeSeconds: number;
  totalTimeSeconds: number;
  totalPoints: number;
  totalStops: number;
  startPoint: { lat, lng };
  endPoint: { lat, lng };
}
```

## WebSocket Messages

```

// Client → Server
{ type: "subscribe", vehicleIds: string[] }
{ type: "unsubscribe", vehicleIds: string[] }

// Server → Client
{ type: "position_update", vehicleId: string, position: VehiclePosition,
movementStatus, connectionStatus, timestamp }
{ type: "connection_status", vehicleId: string, status: RetransmissionStatus,
lastConnection }
{ type: "alert", vehicleId: string, alertType: "geofence_enter" | "geofence_exit"
| "speed_limit" | "connection_lost" | "sos", message, timestamp }

```

## GeofenceEvent

Campo	Tipo	FK
geofenceId	string	→ Geofence
vehicleId	string	→ Vehicle
driverId	string	→ Driver
orderId	string	→ Order
milestoneId	string	→ OrderMilestone
eventType	"entry" \  "exit" \  "dwell"	
status	"active" \  "completed" \  "cancelled"	
timestamp	string	
coordinates	{ lat, lng }	
wasExpected	boolean	
arrivedOnTime	boolean	
timeDifferenceMinutes	number	

## 15. Notification (Notificación)

### Enums

```

NotificationChannel = "email" | "sms" | "push" | "in_app" | "webhook"
NotificationCategory = "order" | "driver" | "vehicle" | "maintenance" | "document"
| "geofence" | "alert" | "system"
NotificationPriority = "low" | "medium" | "high" | "urgent"
NotificationStatus = "pending" | "sent" | "delivered" | "read" | "failed" |
"cancelled"

```

## SystemNotification

Campo	Tipo	FK
title	string	
message	string	
category	NotificationCategory	
priority	NotificationPriority	
channel	NotificationChannel	
status	NotificationStatus	
userId	string	
relatedEntity	{ type, id, name? }	→ Cualquier entidad
actionUrl	string	
readAt	string	
expiresAt	string	

## NotificationPreferences

```
{
  userId: string;
  channels: {
    [category: NotificationCategory]: NotificationChannel[];
  };
  quietHours?: {
    enabled: boolean;
    startTime: string; // HH:mm
    endTime: string;
  };
  dailyDigest?: boolean;
  soundEnabled?: boolean;
}
```

## 16. Report (Reportes)

### Enums

```
ReportType      = "operational" | "financial" | "fleet" | "driver" | "customer"
| "order" | "route" | "maintenance" | "fuel" | "incident" | "compliance" | "kpi" |
"custom"
ExportFormat    = "pdf" | "excel" | "csv" | "json" | "html"
ScheduleFrequency = "once" | "daily" | "weekly" | "biweekly" | "monthly" |
```

```
"quarterly" | "yearly"
ReportStatus      = "pending" | "generating" | "completed" | "failed" | "expired"
```

## GenerateReportRequest

```
{
  definitionId?: string;
  templateId?: string;
  name?: string;
  parameters?: Record<string, unknown>;
  filters?: ReportFilter[];
  dateRange?: { start: string; end: string };
  format: ExportFormat;
  async?: boolean;    // Si true, retorna ID para polling
}
```

## GeneratedReport (respuesta)

Campo	Tipo
status	ReportStatus
format	ExportFormat
fileUrl	string (cuando completed)
fileSize	number
rowCount	number
errorMessage	string (cuando failed)

## 17. Settings (Configuración)

### Enums

```
SettingCategory  = "general" | "operations" | "fleet" | "finance" |
"notifications" | "security" | "localization" | "appearance" | "advanced"
IntegrationStatus = "active" | "inactive" | "error" | "pending"
PermissionLevel   = "none" | "read" | "write" | "admin"
```

### Role

Campo	Tipo
code	string Único
name	string

Campo	Tipo
permissions	RolePermission[]
isSystem	boolean (no eliminable)
isActive	boolean
userCount	number

## RolePermission

```
{
  resource: string;      // "orders", "drivers", "vehicles", etc.
  actions: {
    create: boolean;
    read: boolean;
    update: boolean;
    delete: boolean;
  }
}
```

## Integration

Campo	Tipo
code	string
type	"gps" \  "erp" \  "crm" \  "payment" \  "maps" \  "sms" \    "email" \  "webhook" \  "other"
status	IntegrationStatus
baseUrl	string
lastSyncAt	string
lastError	string
syncIntervalMinutes	number

## AuditLogEntry

```
{
  timestamp: string;
  userId: string;
  userName: string;
  action: "create" | "read" | "update" | "delete" | "login" | "logout" | "export"
  | "import" | "config";
  resource: string;
  resourceId?: string;
  changes?: Array<{ field: string; oldValue: unknown; newValue: unknown }>;
```

```
    ipAddress?: string;
    userAgent?: string;
}
```

## SecuritySettings (referencia para backend)

```
{
  passwordMinLength: number;           // Default: 8
  passwordRequireUppercase: boolean;
  passwordRequireLowercase: boolean;
  passwordRequireNumbers: boolean;
  passwordRequireSpecialChars: boolean;
  passwordExpirationDays: number;
  maxLoginAttempts: number;
  lockoutDurationMinutes: number;
  sessionTimeoutMinutes: number;
  enableTwoFactor: boolean;
  twoFactorMethod: "email" | "sms" | "app";
  enableAuditLog: boolean;
  auditLogRetentionDays: number;
  apiRateLimitPerMinute: number;
}
```

## OperationsSettings (referencia para backend)

```
{
  autoAssignOrders: boolean;
  autoAssignRules: { byZone, byCapacity, byDistance, byWorkload };
  maxOrdersPerVehicle: number;
  maxOrdersPerDriver: number;
  deliveryTimeWindowMinutes: number;
  requireSignature: boolean;
  requirePhoto: boolean;
  requireGeolocation: boolean;
  enableRouteOptimization: boolean;
  routeOptimizationAlgorithm: "nearest" | "genetic" | "savings";
  workingHours: { start, end };
  workingDays: number[]; // 0-6
}
```

## 18. Mapa de relaciones (Foreign Keys)

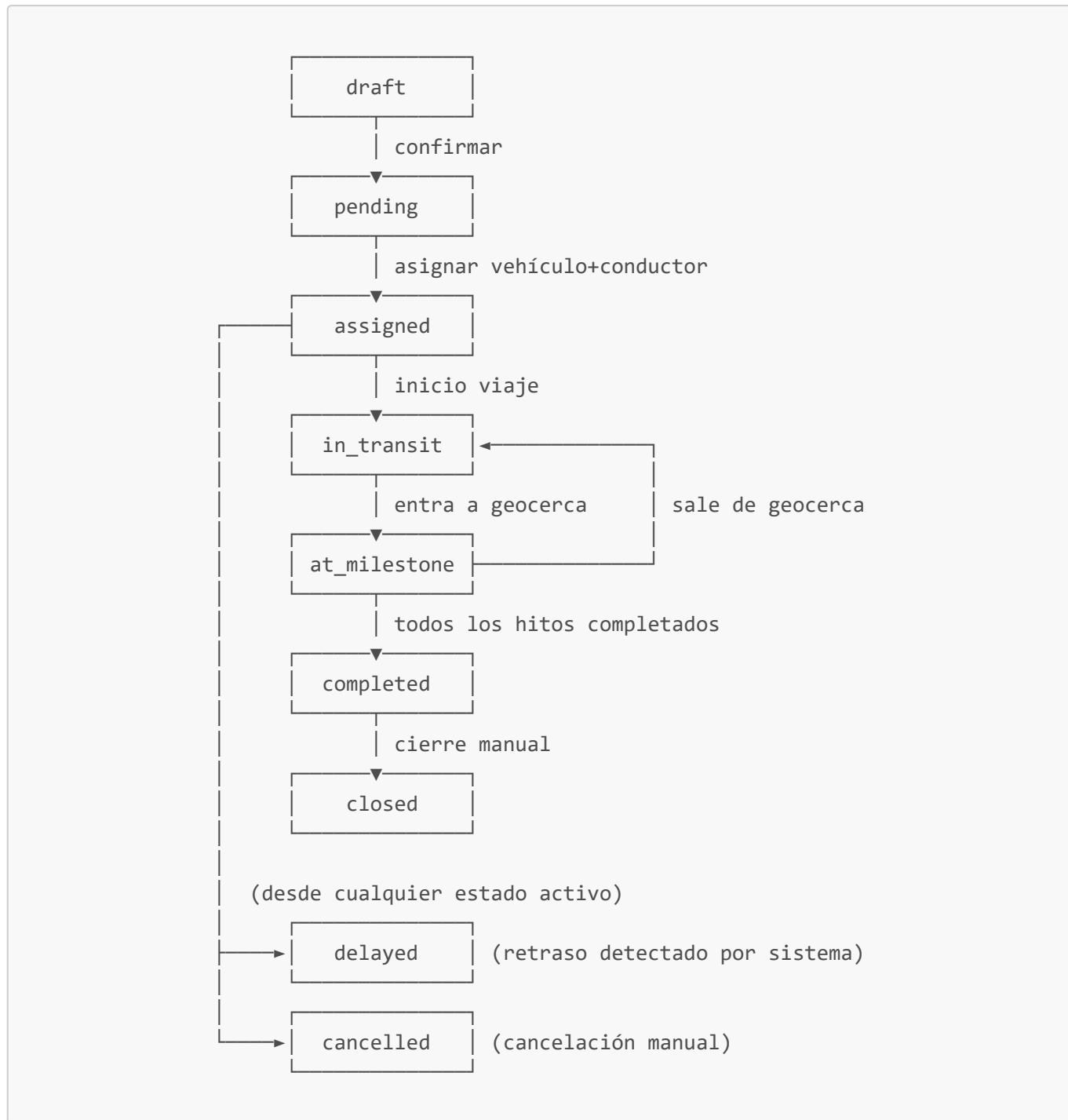
DIAGRAMA DE RELACIONES

Order.customerId → Customer.id

Order.carrierId	→ Operator.id
Order.vehicleId	→ Vehicle.id
Order.driverId	→ Driver.id
Order.gpsOperatorId	→ Operator.id
Order.workflowId	→ Workflow.id
OrderMilestone.orderId	→ Order.id
OrderMilestone.geofenceId	→ Geofence.id
Invoice.customerId	→ Customer.id
Invoice.orderIds[]	→ Order.id[]
Invoice.relatedInvoiceId	→ Invoice.id (notas crédito/débito)
InvoiceLineItem.orderId	→ Order.id
Payment.invoiceId	→ Invoice.id
Payment.customerId	→ Customer.id
TransportCost.orderId	→ Order.id
TransportCost.vehicleId	→ Vehicle.id
TransportCost.driverId	→ Driver.id
ServiceRate.customerId	→ Customer.id
Driver.operatorId	→ Operator.id
Driver.assignedVehicleId	→ Vehicle.id
Vehicle.operatorId	→ Operator.id
Vehicle.currentDriverId	→ Driver.id
Geofence.customerId	→ Customer.id
Product.customerId	→ Customer.id
Customer.preferredWorkflowId	→ Workflow.id
GeofenceEvent.geofenceId	→ Geofence.id
GeofenceEvent.vehicleId	→ Vehicle.id
GeofenceEvent.driverId	→ Driver.id
GeofenceEvent.orderId	→ Order.id
GeofenceEvent.milestoneId	→ OrderMilestone.id
IncidentRecord.orderId	→ Order.id
IncidentRecord.catalogItemId	→ IncidentCatalogItem.id
IncidentRecord.milestoneId	→ OrderMilestone.id
Workflow.applicableCustomerIds	→ Customer.id[]
Workflow.applicableCarrierIds	→ Operator.id[]
WorkflowStep.actionConfig.geofenceId	→ Geofence.id
WorkflowProgress.workflowId	→ Workflow.id
WorkflowProgress.orderId	→ Order.id
RetransmissionRecord.vehicleId	→ Vehicle.id
RetransmissionRecord.gpsCompanyId	→ GpsCompany.id
TrackedVehicle.driverId	→ Driver.id
TrackedVehicle.activeOrderId	→ Order.id
Notification.relatedEntity.id	→ (Order Driver Vehicle Customer ...)

## 19. Máquinas de estado

### 19.1 Order Status

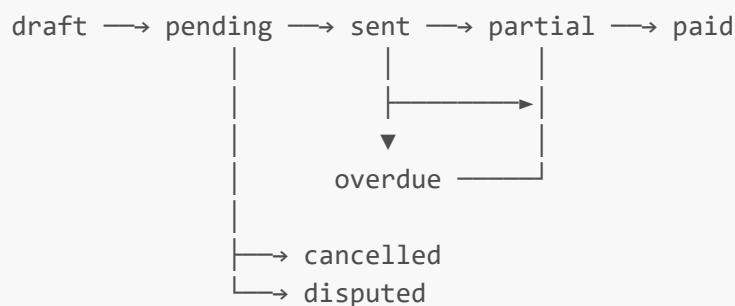


#### Transiciones válidas:

Desde	Hacia	Condición
<b>draft</b>	<b>pending</b>	Confirmar orden
<b>draft</b>	<b>cancelled</b>	Cancelar borrador
<b>pending</b>	<b>assigned</b>	Asignar vehículo y/o conductor

Desde	Hacia	Condición
pending	cancelled	Cancelar
assigned	in_transit	Iniciar viaje
assigned	cancelled	Cancelar
in_transit	at_milestone	Vehículo entra a geocerca
in_transit	delayed	Retraso detectado
in_transit	cancelled	Cancelar
at_milestone	in_transit	Vehículo sale de geocerca
at_milestone	completed	Último hito completado
at_milestone	delayed	Retraso detectado
delayed	in_transit	Retoma ruta
delayed	at_milestone	Llega a hito tardío
delayed	completed	Completa tardíamente
completed	closed	Cierre manual con datos

## 19.2 Invoice Status

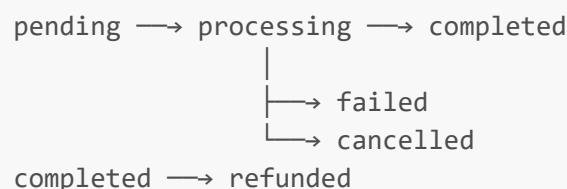


### Transiciones válidas:

Desde	Hacia	Condición
draft	pending	Completar factura
pending	sent	Enviar al cliente
pending	cancelled	Cancelar
sent	partial	Pago parcial recibido
sent	paid	Pago total recibido
sent	overdue	Venció fecha de pago (automático)
sent	disputed	Cliente disputa

Desde	Hacia	Condición
partial	paid	Monto restante recibido
partial	overdue	Venció fecha
overdue	paid	Pago tardío recibido
overdue	cancelled	Cancelar vencida
disputed	sent	Resolución de disputa
disputed	cancelled	Cancelar por disputa

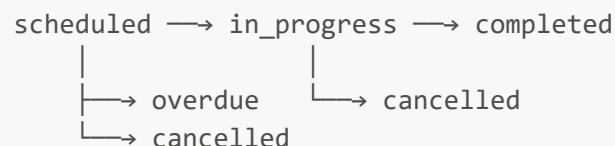
### 19.3 Payment Status



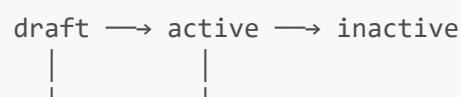
### 19.4 Milestone Status



### 19.5 Maintenance Status



### 19.6 Workflow Status




---

## 20. Reglas de validación

## 20.1 Documentos de identidad peruanos

Documento	Formato	Validación
<b>RUC</b>	11 dígitos	Prefijo <b>10/15/16/17/20</b> + algoritmo módulo 11
<b>DNI</b>	8 dígitos	Solo números, no patrones inválidos (00000000, etc.)
<b>CE</b>	7-12 alphanum	Alfanumérico, uppercase
<b>Passport</b>	6-12 alphanum	Alfanumérico

## 20.2 Licencia de conducir

- Formato: **^[A-Z]\d{8}\$** (ej: Q12345678)
- Fecha emisión no puede ser futura
- Verificación de vigencia y status **verified**

## 20.3 Placas vehiculares peruanas

```
^[A-Z]{3}-\d{3}$      // ABC-123
^[A-Z]\d[A-Z]-\d{3}$  // A1B-234
^[A-Z]{2}\d-\d{3}$    // AB1-234
```

## 20.4 VIN/Chasis

- Exactamente 17 caracteres
- Regex: **^[A-HJ-NPR-Z0-9]{17}\$** (excluye I, O, Q)

## 20.5 Teléfono

- Regex: **^\+?[0-9\s-]{9,15}\$**

## 20.6 Conductor

- Edad: 18-70 años (calculado desde birthDate)
- Nombre: 2-50 chars
- Código: 3-20 chars
- Dirección: 10-200 chars
- Notas: max 1000 chars

## 20.7 Vehículo

- Año: 1990 - año actual+1
- Tanque combustible: 10-500 galones
- Ejes: 2-10
- Ruedas: 4-24
- maxPayload ≤ grossWeight - tareWeight**
- Seguro: endDate > startDate

- IMEI GPS: exactamente 15 dígitos
- 

## 21. Reglas de negocio

### 21.1 Compatibilidad licencia-vehículo (normativa MTC Perú)

Licencia	Vehículos permitidos	Peso máximo
A-I	pickup, minivan	500 kg
A-IIa	+ furgoneta	3,500 kg
A-IIb	+ camion	6,000 kg
A-IIIa	+ tractocamion	12,000 kg
A-IIIb	+ remolque, semiremolque	Sin límite
A-IIIc	+ cisterna, volquete (MATPEL)	Sin límite

### 21.2 Elegibilidad del conductor

El conductor solo puede operar si **TODOS** estos criterios se cumplen:

1.  Licencia vigente Y verificada
2.  Examen médico vigente Y aprobado
3.  Examen psicológico vigente Y aprobado
4.  Antecedentes policiales vigentes Y limpios
5.  Antecedentes penales vigentes Y limpios
6.  Certificaciones requeridas vigentes

### 21.3 Elegibilidad del vehículo

El vehículo solo puede operar si **TODOS** estos criterios se cumplen:

1.  SOAT vigente Y verificado
2.  RC Obligatorio vigente Y verificado
3.  Inspección técnica vigente Y aprobada
4.  Certificado de operación vigente Y verificado
5.  GPS instalado, activo Y certificación vigente

### 21.4 Certificaciones por tipo de operación

Tipo operación	Certificaciones requeridas
General	sst_induction, defensive_driving
MATPEL	matpel, hazmat Awareness, first_aid, fire_safety
Cadena de frío	cold_chain, sst_induction
Atención al cliente	customer_service, sst_induction

## 21.5 Seguros obligatorios

Tipo operación	Seguros requeridos
General	SOAT, RC Obligatorio
MATPEL	SOAT, RC Obligatorio, RC Complementario
Carga valiosa	SOAT, RC Obligatorio, Seguro de carga

## 21.6 Intervalos de mantenimiento

Tipo	Cada (km)	Cada (días)	Descripción
Cambio aceite	10,000	180	Aceite y filtros
Frenos	20,000	180	Inspección de frenos
Neumáticos	15,000	180	Rotación
Servicio completo	50,000	365	Full service
Transmisión	60,000	730	Servicio transmisión
Enfriamiento	40,000	365	Sistema cooling

## 21.7 Categorías MTC por vehículo

Vehículo	Categorías MTC
pickup, minivan	M1, N1
furgoneta	N1, N2
camion	N2, N3
tractocamion	N3
remolque	O2, O3, O4
semiremolque	O3, O4
cisterna	N3
volquete	N2, N3

## 21.8 Inspección frecuente por antigüedad

- Vehículos con **≥10 años** requieren inspección técnica **semestral** (en vez de anual)

## 21.9 Alertas de vencimiento

Días restantes	Nivel
> 30	ok (verde)

Días restantes	Nivel
16-30	warning (amarillo)
1-15	urgent (naranja)
≤ 0	expired (rojo)

## 21.10 Horas de servicio (HOS)

- Máximo horas/día: configurable (default 8, max 12)
- Máximo horas/semana: configurable (default 48, max 60)
- Descanso obligatorio después de: configurable (default 4h)
- Duración mínima descanso: configurable (default 30min)
- Conducción nocturna: configurable (permitido/prohibido con horario)

## 21.11 Órdenes

- Solo se puede eliminar en estado `draft`
- Solo se puede asignar vehículo/conductor en estado `pending`
- Solo se puede iniciar viaje en estado `assigned`
- Solo se puede cerrar en estado `completed`
- `completionPercentage` se calcula automáticamente según hitos completados

## 21.12 Facturas

- `amountDue = total - amountPaid` (calculado)
- Si `amountPaid > 0 && amountPaid < total` → estado `partial`
- Si `amountPaid >= total` → estado `paid`
- Si `dueDate < hoy && amountDue > 0` → estado `overdue` (job automático)
- Notas de crédito (`type: "credit"`) deben referenciar `relatedInvoiceId`

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Este documento junto con [API\\_CONTRACT.md](#) proporciona toda la información necesaria para que el equipo de backend diseñe la base de datos, implemente los endpoints y las reglas de negocio.