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Article

Developing a 3-statement operating and financial performance model for truck and rail infrastructure business: A case study of a model with automated retirement/reinvestment schedule

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Abstract: This financial modelling case study describes the development of the 3-statement financial model for a large-scale transportation infrastructure business dealing with truck (and some rail) modalities. The financial modelling challenges in this area, especially for large-scale transport infrastructure operators, lie in automatically linking the operating activity volumes with the investment volumes. The aim of the paper is to address these challenges: The proposed model has an innovative retirement/reinvestment schedule that automates the estimation of the investment needs for the Business based on the designated age-cohort matrix analysis and controlling for the maximum service ceiling for trucks as well as the possibility of truck retirements due to the reduced scope of tracking operations in the future. The investment schedule thus automated has a few calibrating parameters that help match it to the current stock of trucks/rolling stock in the fleet, making it to be a flexible tool in financial modelling for diverse transport infrastructure enterprises employing truck, bus and/or rail fleets for the carriage of bulk cargo quantifiable by weight (or fare-paying passengers) on a network of set, but modifiable, routes.

Keywords: 3-statement financial models; age-cohort matrix; investment project appraisal; business valuation; investment schedule; asset retirement cohorts; financial modelling
JEL Classification: G31

1. Introduction

The transportation industry in road and transport modalities has faced significant disruptions, both in terms of operating volumes and modalities, following the Covid 19 pandemic (Loske, 2020; Hassan et al., 2022). Additionally, the expected economic obsolesce of diesel-based trucking solutions may soon force diesel truck operators to revise utilization schedules for their fleets. The case study enterprise in this paper, with more than 400 tankers, operates in the petrol transportation industry and is faced with the impending challenges of reduction in fuel transportation volumes as the passenger car fleet increasingly migrates to electric traction. On the financial management level, this has called for the development of a flexible financial model for the enterprise in which retirement/reinvestment schedules for the fleet can be made automatically responsive to ups and downs in operating projections for the transportation volumes (e.g., as stated in tonne-kilometres of fuel shipment).

To this end, in this case study we describe a 3-statement financial model developed for a road and truck petrol transportation company in accordance with the generally accepted financial modelling practices. The aim of the model was to integrate, using a modular approach, operating and investment activities in different transportation modalities and operational regions of the enterprise such that long-term financing and dividend decisions can reasonably be taken at the enterprise level. On top of it, the strategic aim of the model was to provide a Discounted cash flow (DCF)—based dynamic tool for estimating the value of the invested capital and equity value of the enterprise using the conventional understanding of these concepts in Business valuation, and analyze the impact of truck and rail asset re-valuations on these values.

It is believed that the way in which the retirement/reinvestment schedule is endogenized and automated in the discussed financial model based on the age-cohort analysis has some novelties not previously reported in the financial modelling literature, so the case study makes emphasis on those elements. Notably, the increasingly observed secular down-trend in the operating activities for fuel transportation industry conditions the proposed retirement/reinvestment algorithm to place an additional emphasis on the option of retiring trucks other than through natural decommissionings (i.e., due to reaching the age limits of service). Overlooking this aspect may make the business investment needs algorithms not sufficiently responsive to dynamic changes in the operating environment, flagging a dangerous case of a strategically misaligned model (Swan, 2007). Additionally, the disposal of operationally redundant and not fully run-down trucks on the second-hand market can open up an opportunity to bring in extra cash flow to the enterprise at projected market prices and shouldn’t be overlooked in retirement/reinvestment algorithms.

The paper is organized as follows. Section 2 reviews the state-of-art in financial modelling for transportation industries and indicates the lacunae in literature associated with the treatment of automated reinvestment schedules. Section 3 is the major section of the paper; it provides for the context of the case study and deals with the data collection and financial modelling methodology employed in the case study, emphasising the integrated 3-statement nature of the modelling adopted. Subsection 3.2.2. on modelling investment activities on an enterprise level is key to the paper as it contains an algorithmic proposal for automating retirement/reinvestment schedules and explains how to implement it in the Excel medium. Section 4 presents an output of the conducted financial modelling in the case study, followed by the conclusion.

2. Literature review

Infrastructure companies in transportation industry were among the early adopters of modern budgeting and financial modelling techniques, as well as driving their development. The interest in budgeting and financial models for the truck transportation industry has started even before the spreadsheets became available—e.g., see Botin (1975) for early efforts in this direction using the Fortran programming language.

The best financial modelling practice is outlined in such sources as Avon (2021), Damodaran (2014), Pignataro (2013), Rees (2018), Swan (2016), Tennent and Friend (2005), and with a focus on financial model depreciation schedules (Access Analytic, 2021). Modelling business ventures in transportation industries has its own peculiarities and is important from the macroeconomic standpoint (Hilliard, 1985)—

so much so that The World Bank has seen fit to develop a high-level capacity-building material for that field (The World Bank, 2021), while different jurisdictions have supported the development of dedicated financial projection software for state transportation industry players (Queiroza and Mladenovicb, 2020). Financial model aggregators (such as Efinancialmodels (2023) and Projectionhub (2023)) list several dozens of publicly available models for transportation industries, and about a dozen of financial models specifically tailored as solutions for the trucking industry. While many models address particular operating and investment facets of the truck usage (see Rout et al. (2022) for the inventory of total lifetime costs to be considered for different types of trucks; see Škerlič and Sokolovskij (2020) for the list of models related to operating cost optimizations; see Galkin et al. (2021) for the analysis of operating costs for own vs. rent options), a few such models also comprehensively incorporate a desirable set of key operating and investment indicators that planning systems at modern transport enterprises can't do without (Prievozník et al., 2021). However, in none of the available models is the investment schedule automatically linked to any of the indicators associated with the volume of operating activities, albeit the importance of such linking is frequently emphasized in research literature (e.g., see Malykha et al. (2023) on the importance of a system for linking the decommissioning of agricultural equipment to operating plans of enterprises in the agricultural sector). For the most part, the investment schedules are based on manual inputs or are only automated to the extent of enabling the recording of replacements at parity. This approach is feasible for smaller transportation businesses but loses relevance for financial models tailored to big infrastructure entities, like the case study enterprise. Other available case studies of financial models for logistics businesses (Fang et al., 2013). Wania (2021) explains and illustrate the overall steps involved in building transportation-related financial models, but mostly focus on operational aspects of their case study businesses to the exclusion of emphasis on automating the re-investment schedules. Thus, the survey of publicly available literature identifies a hiatus in discussions of integrated dynamic investment schedules for transportation-related financial models, which this paper attempts to bridge. We do it while remaining in the framework of a formal programming logic, but cognizant of the latest exciting breakthroughs in the field of deep calibration of financial models using Artificial neural networks (ANN), which framework can also be brought to bear on the problems discussed (Buchel et al., 2022).

3. Data and methodology

3.1. Data organization and collection: Case study enterprise and associated financial model architecture

Case study data come from an East European enterprise which is fully controlled by a government infrastructure company and is engaged in fuel transportation in truck and road modalities. The financial model's projections are rooted in historic management accounting data for Years 2019–2020 collected from the company's ERM database. Any further retrospective was deemed unnecessary in view of the undergoing restructuring as explained below.

In terms of its architecture, this case study describes an aggregative financial model, with the central-level tab aggregating data from segment-specific tabs for operational units (and investment projects). The model relates to an established petrol-haulage business constituted of (1) realized investment projects managed by operating units, as well as (2) ongoing investment projects, and (3) a rail investment project planned for the near future. We have to account for the contribution of all these constituent parts of the business to its Equity value through the medium of a 3-statement financial model.

There are two distinct types of differently structured operations (segments) in the case study business: Truck and Rail. Units in the truck segment are engaged in transporting petrol from refineries to petrol pumps in their operating region. These units are organized on the geographical principle and have sub-units, with the latter being endowed with the truck-and-cistern fleet. For each sub-unit—and the Company has 19 operating sub-units managed from 6 regional units (A–F)—there is a separate segment-specific spreadsheet in the model, for example, "BK 3" spreadsheet records forecast operations of the 3rd sub-unit of the trucking unit B. Additionally, following the aggregative spreadsheet "Sum RAIL", there are 3 spreadsheets for the rail segment of the company operations. Of these, the first spreadsheet "Current rail" describes operations based on the currently existing rolling stock of the company, while the Spreadsheets "Rail invest 660" and "Rail Invest 850" represent Investment plans to purchase new rolling stock (with the Rail Invest 850 purchases to be completed after the commencement date of the model).

The trucking operations of the company are based on the fully-owned standard fleet of 400+ trucks and cisterns (making up articulated trailer-couplings)—since it is how the petrol is usually transported: a trailer-coupling has a truck pulling an attached petrol trailer. The coupling is often referred to as an "articulated tanker", but it should be noted that for haulage the cistern-trailers are compatible with any modern trucks and are sold separately from the trucks by dealers (See **Figures 1** and **2**).

Figure 1. KRANTAS Petrol trailers already used by the company (capable of transporting 22.5 tones of different types of petrol and diesel fuel in 3 compartments).

Figure 2. MAN 4 × 2 435 hp tractor-trucks are used by the company in all its 19 operating petrol haulage sub-units.

The Company's clients in the trucking segment are multiple petrol pump operators across the constituent national regions which contracted with the company for deliveries of fuel from refineries and storage facilities[1] and pay on the basis of the negotiated transportation tariffs and the physical volume of transportation services performed by the tankers (with the usual deferral in payment for up to 30 days following the closure of the month and the reconciliation of fuel receipt invoices). The contractual revenue formula for the Company's trucking units has three drivers and looks as follows:

Revenue per period = the tariff (denominated in dinars per tonne × km[2]) × Length of the transportation leg (in kms)[3] × tons of petrol offloaded to the petrol pump per period.

The model we are studying is needed for the purpose of a financing decision: to demonstrate to the company's management different combinations of feasible Financing/Dividend policies for the business, having in mind the need to fund the mentioned rail investment projects and the fact that the existing company's truck fleet wears down fast and will need replacing at some point[4]—so if the dividends are paid with abandon right now[5] the Company won't be able to accumulate enough cash on its balance sheet to replace trucks when their replacement comes due.

Comprehensive 3-statement financial models are able to address all sorts of questions, including with respect to Financing and Dividend policies. For that, though, we have to model not individual investment projects, but to—literally—regard a company as a portfolio of past (ongoing) and new investment projects (Rail Invest 660,850 projects, in our instance). The model we are to develop achieves exactly that[6]. With the model in place, we are effectively straddling the subject of Investment project appraisal and that of a business valuation. As this case study shows, the technical approaches adopted are exactly the same. In the end of the day, the model will also report FCFE-based Valuation for 100% Equity in the Company (Line 687 of the "Centre" spreadsheet).

So let's summarize the features of the case study model (**Table 1**).

Table 1. Key features of the case-study model: rail and truck business.

Features of the model	Description
General description and purpose	3-statement integrated financial model for modelling a transportation business (the company) with the object of establishing its investment needs and outlining optimal long-term Financing and Dividend policies, as well as developing its Equity valuation (=establishing value of its 100% equity interest).
Key model features	Nominal model, denominated in Serbian currency (Dinar: 1 USD = approx. 100 dinars). Forecast period—10 years, developed at an annual frequency. With Gordon-formula-based terminal value for the needs of valuing equity (based on NPV(FCFE)).
Analysis, commencement dates for the model	The Analysis date (Date developed) for the model—August 2020 (based on 30/06/2020 reporting statements). Commencement date (date of the entry balance sheet for the model)—01/01/2021. Terminal year—2032 (not modelled explicitly).
Notable features of the model	1. The model provides for modelling PP&E revaluations for the entry balance sheet as of 01/01/2021 (updating carrying amounts for the property and rolling stock to their current market values). 2. The model proposes an ingenious framework for automatically estimating retirement and re-investment needs for trucks depending on the expected operational demands (transportation volumes) of the business. 3. The model provides flexible loan amortization schedules allowing to explore accelerated patterns of loan repayments.

Source: Own analysis.

The level of detail in the model can be daunting and it can be open to the charge of being too meticulously planned, but it should be borne in mind that the effect of every item being accounted for propagates through all the 19 operating divisions (sub-units) of the Company.

Further discussion of the model's methodology for truck-specific spreadsheets in the model (AK1-FK1 tabs) is split into its operational and investment aspects, with details related to rail operations provided subsequently.

3.2. Methods and algorithms applied in the model

3.2.1. Estimating operating needs for the truck fleet

The starting point is to be able to establish needs for the truck fleet and how those evolve over time.

In every region, the network of petrol pumps being serviced is located at fixed distances from the refineries which supply petrol. In fact, the managers of units have a good idea of the average weighted "transportation legs" for their units, meaning the average one-way distance from refineries to petrol pumps weighted by the volume of fuel transported and having regard to truck routing considerations. The length of transportation leg for each unit (in kms) gives the idea of an average distance from the refinery to a single representative petrol pump in the region. Such that, effectively, we can substitute modelling complex logistical transportation schedules and timetables specific to each region with a simple idea that the unit's trucks will only ply one route from the refinery to the single representative petrol pump (sited at a distance from the refinery that corresponds to the unit's transportation leg measure) and back. How many trucks (and cisterns) will we need to be able to transport the given volume of petrol products as are actually observed being transported by the unit per month?

To answer this question, we first need to develop the idea of the truck "runs"—how many times per day will a truck be able to ply the route from the refinery to the destination (end of the leg) and back? The answer obviously depends on the business hours of the refineries (some are open for business 24 h per day, others work only for

10–12 h per day), the time it takes to fill the cistern up and off-load it (2.8 h per each run in our case study), and the average speeds end route. Also, consider the fact that on long transportation legs, the drivers have to rest for half an hour after about 4 h of continuous driving. Considering all these factors together, we develop the number of transportation runs per truck per day in Row 38 of the truck segment-specific spreadsheets. It is obvious that over each run the truck will only be able to transport as much fuel as fits into its cistern-trailer (22.5 tones at 0.75 average density for petrol and diesel products[7]). Therefore, such cistern tonnage times the number of truck runs per day is the maximum fuel tonnage that each tanker coupling will be able to transport per day in the given region/unit. Knowing it, we can easily deduce the number of truck couplings required for the transportation of the given output of refinery products (the statistics on the tonnage of refinery products transported per month by each unit—i.e., from each refinery[8]—is the primary statistics produced by the managers of each unit and is therefore readily available). The respective calculations are made in Row 39 of truck segment-specific tabs with allowance for the observed downtime factor in the truck fleet (due to breakdowns etc.).

The proposed approach to deducing truck coupling needs is a standard, well-established one in the industry. The calibrating parameter for it is the average speed en route (Line 36 of the truck-specific tabs). It is known that for units with shorter average transportation legs, the average speed of transportation is also less—since the last 20 or so km of the leg would fall on transportation in traffic-jammed urban conurbation zones.

3.2.2. Computing truck/cistern investment needs: Automated retirement/reinvestment and investment schedules

Knowing how many trucks/couplings a transportation operation will need every year enables us to deduce the truck retirement and re-investment schedules for each unit for many years ahead, having regard to the age structure of the unit's fleet at the commencement date of the model (01/01/2021) and the (exogenous) constraint that the trucks should, on average, be retired at the end of a year when they reach the service ceiling of 800k km. However, the intensity of use for the trucks in terms of the average annual mileage (on Line 7 of the truck segment-specific tabs) differs across different units. So this service ceiling of 800k km will be expected to be reached at a different average age for the trucks serving in different units.

To develop the truck retirement and reinvestment schedule for each unit, we start with the notion of cohorts. Trucks commissioned into a company's unit in a particular year represent a particular age cohort. Notice that the Company has a policy of investing in new transportation equipment only. Thus, trucks of age 0 (the new ones) in 2017 are the trucks belonging in the 2017 age cohort and at the commencement date of the model (01/01/2021) this cohort is counted as "trucks aged 3 years". In the retirement and reinvestment schedule of, say, Unit AK1 (Cell field A43:A86 in the truck segment-specific tabs) reproduced below (see **Table 2**), we can see how the initial cohort input at the commencement date of the model (Column C) migrates south-east (as per the arrows) down the schedule till the cohorts reach their retirement age and, in consequence, are disposed of (by selling trucks on the second-hand market) and replaced with the new reinvestments (in Lines 46–47 of truck segment specific spreadsheets) representing the start of new cohorts belonging to the replacement year. For each cohort age, the blue cells in **Table 2** summarize the cohort migrations inwards (from "age-1" block) and outwards (that is, retirements of the cohort)[9]. The basic cohort migration principle is simple: the balance of "trucks aged *X*" (in the blue rows) is wholly transferred as a sole input to "trucks aged $X + 1$" in the next year (the green rows). When the cohort has reached its designated retirement age (indicated in Line 12 of the truck segment-specific tabs) it is written off in full at that year's end (as indicated in "–" rows). Line 86 summarizes the total number of trucks in the unit obtaining at the year's end across all the age cohorts (having regard to the decommissioning due to age in that year).

What is the meaning, then, of the seemingly duplicating line "absolute decommissioning" which is recorded for all the cohorts aged 3 years and above in a particular year? As mentioned above, the company management is worried that the volumes of transportation can decline across all units with time and therefore the existing truck fleet can become redundant. While for a slow decline in the volumes of transportation we can regulate the number of trucks in the fleet by retiring the old cohorts while re-investing slightly less in the new ones than the retired number, for a more precipitous decline, and to keep the model flexible, we may also have to additionally retire trucks from a cohort aged one year less than the designated retirement age.

Table 2. Truck retirement and reinvestment schedule (the age-cohort matrix-cells A43:N86 of the truck segment-specific tabs), with arrows depicting the cohort migrations till retirement and replacement.

Age-quantity matrix (aka retirement-reinvestment schedule) for estimating the total number of trucks needed for service, new investments into trucks and decommissioning		**Commencement date**	**2021**	**2022**	**2023**	**2024**	**2025**
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Colour code:		Sum of the coloured cells below:	+	−			
Demand for trucks in the unit—end of period	-	-	52	52	52	51	50
Breakdown of unit trucks by service age	Age in 2020	Number of					
Trucks aged 0 years (for 2020 those purchased in 2020)	0	11	0	0	39	1	0
+ due to new needs and decommissioning	-	-	0	0	39	0	0
+ due to new needs and decommissioning	-	-	0	0	0	1	0
–	-	-					
−Absolute decommissioning	-	-					
Trucks aged 1 year	1	0	11	0	0	39	1
+	-	-	11	0	0	39	1
–	-	-					
Absolute decommissioning	-	-	0	0	0	0	0
Trucks aged 2 years	2	2	0	11	0	0	39
+	-	-	0	11	0	0	39
–	-	-					
−Absolute decommissioning	-	-	0	0	0	0	0

Trucks aged 3 years	3	39	2	0	11	0	0
+	-	-	2	0	11	0	0
−	-	-	0	0	0	0	0
−Absolute decommissioning	-	-	0	0	0	0	0
Trucks aged 4 years	4	0	39	2	0	11	0
+	-	-	39	2	0	11	0
−	-	-	0	0	0	0	0
−Absolute decommissioning	-	-	0	0	0	0	0
Trucks aged 5 years	5	0	0	39	2	0	10
+	-	-	0	39	2	0	11
−	-	-	0	0	0	0	0
−Absolute decommissioning	-	-	0	0	0	0	−1
Trucks aged 6 years	6	0	0	0	0	0	0
+	-	-	0	0	39	2	0
−	-	-	0	0	−39	−2	0
−Absolute decommissioning	-	-	0	0	0	0	0
Trucks aged 7 years	7	0	0	0	0	0	0
+	-	0	0	0	0	0	0
−	-	-	0	0	0	0	0
−Absolute decommissioning	-	-	0	0	0	0	0
Trucks aged 8 years	8	0	0	0	0	0	0
+	-	-	0	0	0	0	0
−	-	-	0	0	0	0	0
−Absolute decommissioning	-	-	0	0	0	0	0

Table 2. (*Continued*).

Age-quantity matrix (aka retirement-reinvestment schedule) for estimating the total number of trucks needed for service, new investments into trucks and decommissioning		**Commencement date**	**2021**	**2022**	**2023**	**2024**	**2025**
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Trucks aged 9 years	9	0	0	0	0	0	0
+	-	-	0	0	0	0	0
−	-	-	0	0	0	0	0
−Absolute decommissioning	-	-	0	0	0	0	0
Total number of trucks serving the unit (end of period)	-	52	52	52	52	51	50
Need for truck retirements over and above the decommissioning of the oldest cohort due to age	-	-	0	0	0	0	1
Average age of trucks in the unit	-	2.3	3.33	4.33	0.83	1.63	2.58
Count of truck retirements due to the decommissioning of the oldest cohort			0	0	39	2	0
Success in retiring trucks in the cohort preceding the oldest one			yes	yes	yes	yes	yes
Need for net retirements of trucks	-	-	0	0	0	1	1
Difference between the truck needs and their availabilities—end of the period		-	0	0	0	0	0

For example, such a situation is actually to be observed, on a minor scale, for the AK1 unit in the year 2025 (in **Table 2**): By the end of the Year 2024 we expect to have 51 trucks in service in the unit (Line 86), whereas by the end of the Year 2025 the operational need will be for 50 trucks only (Line 41). None of the trucks is expected to leave the service due to the age-associated retirements in 2025, so we have to find a way to retire 1 truck[10] due to the operational needs redundancy. That is the meaning of "−absolute decommissioning" lines in the schedule—that is, decommissioning over and above those conditioned by the retirement considerations and caused by the decline in the operational needs for the fleet.

The workings of the formulas in the "absolute decommissioning" lines of the retirements/reinvestments schedule are as follows. The key reference in the formulas is to Line 87 "Need for truck retirements over and above the decommissioning of the oldest cohort due to age". In this Line, we estimate the absolute retirement needs over and above age-related truck retirements for any given model year. Two conditions should be met simultaneously within the conditional part of the IF function for the absolute retirements to be considered necessary: operating needs for trucks at the end of a year should be less than the operating needs at the beginning (= the end of the previous year) AND the absolute difference between the ending and beginning of period needs (ABS function) that is, a difference ignoring the sign of the difference should be in excess of the number of trucks being retired due to age in that year. That excess (overage) is then estimated in the "If-yes" command part of the IF statements in Line 87 and is withdrawn (in one of the "absolute decommissioning" lines) from that age cohort which is one year younger than the retirement age. Thus, in years with redundant trucks in operation the trucks are to be "naturally withdrawn through retirement" from the retirement-age cohort, but, if such a retirement fails to meet the declining operational needs, additional withdrawals of trucks from service are then taken from a cohort next in line to reaching the retirement age. The IF formulas in "absolute decommissioning" lines of the schedule are so programmed as to avoid withdrawals of trucks from the cohorts in excess of whichever number of trucks is migrating inwards from the previous year: The balance of trucks of a particular age in each particular year can't be negative in the unit, after all (only 0 or positive integers)! The model, however, won't address a case when the retirements of trucks from the one-year-before-retirement cohort fail to equalize the availabilities of trucks with outstanding operational needs. Such cases would be material if the transportation volumes of the business were to decline too precipitously, but, as the analysis in Line 69 of the "Centre" spreadsheet shows, the proposed truck retirement/re-investment schedules equalize the availabilities with the needs for trucks at the company level quite accurately (with an accuracy of up to 2 trucks).

Additionally, Line 90 "Success in retiring trucks in the cohort preceding the oldest one" in truck segment-specific tabs indicates the sufficiency, or otherwise, of involving only the two oldest cohorts in the truck retirement process, and in most of the instances, it returns "yes" to the sufficiency question. This line uses the "INDEX-MATCH" functional combination which is key in Excel to working with array-type data and was also used extensively for looking up data in data tables in lieu of VLOOKUP or HLOOKUP functions (before those two became available). A good way to understand how the INDEX-MATCH combination works is to look at Line 89 which estimates the number of truck retirements from the oldest cohort[11]. You may encounter a formula like that there:

= − INDEX (F45:F85; MATCH($B$12; $B$45:$B$85) + 2)

where, INDEX is a primary function, with the MATCH being the nestled one—at a point where the INDEX function requires indicating a position to show. INDEX means a command to "Show" (datum from a particular spot in an array). In this context, it should show the element/row number "MATCH ($B$12; $B$45:$B$85) +2" in the one-dimensional (vertical) array F45:F85. That array is a column in the retirement/re-investment schedule. So what this entire formula does is coordinate the look-up and matching process across the two aligned data strings (vertical arrays)[12]: B45:B85 (which is the sequential list for the possible ages of trucks to be found in the retirement/re-investment schedule—1, 2, 3 ... 9) and F45:F85 (representing the age structure of the truck fleet (with migrations) in the forecast Year 2023 of the model). The MATCH function finds the number, in the B45:B85 array, corresponding to the one located in cell B12 (the age defining the retirement cohort—that is, "6" for AK1 unit) and determines its sequential position in the array. So, since it indeed finds the number "6" on Line 70 of the spreadsheet (in cell B70), its returns "70 − 45 + 1 = 26", meaning that this number is the 26th member in the B45:B85 array counting from its start on Line 45. This 26th spot is then fed into the INDEX function and this function returns the value of the 26 + 2= 28th element (notice the shift of 2 in the formula above!) but now searching for it in the associated F45:F85 array (not the B array!). This 28th spot in the F45:F85 array/string has the needful value of "−39", meaning 39 trucks are to be written off from the oldest cohort, and we invert the negative sign to get the absolute number of trucks due for retirement/disposal in the unit in that model year.

This is how we can coordinate the search and retrieval of information in any two associated datasets within complex data structures (like 2D tables) using the INDEX-MATCH functional combination. Many financial modellers prefer this combination to alternative VLOOKUP or HLOOKUP Excel functions.

We have so far focused on the retirement process in the truck retirement/re-investment schedule, now on to what concerns the reinvestment part. From vertical arrows in **Table 2** it can be seen that the re-investment process initiates new truck cohorts in the future. In Lines 46–47 of the truck segment specific tabs, we consider two reinvestment scenarios. Line 46 addresses the reinvestment situation under the increasing volume of transportation when the need for trucks at the unit at year's end exceeds (or, at least, is equal to) that at the beginning (the zero or net investment scenario). In this instance, not only do we have to replace the trucks from the retired cohort in full but also add up additional trucks to the unit's fleet to address the positive net investment gap between the truck needs at the year's end vs. those at the beginning. Line 47 addresses the scenario for the (slightly) declining volumes of transportation when at a year's end fewer trucks are to be needed at the unit than at the beginning (the net disinvestment scenario). However, against the backdrop of truck retirements, in case the number of trucks that will be needed at the year's end is estimated at, say, 50, while 52 were available at the beginning, this doesn't mean that we don't have to reinvest at all. Suppose that 8 trucks are being retired during the same year. In that instance, the reinvestment need can be estimated as 50 – 52 + 8 = 6 (we still have to reinvest but not to the full extent of retirements in the aged cohorts). The cases in Lines 46 and 47 are mutually exclusive and exhaust the list of possibilities when any reinvestments can arise. The IF functions in Lines 46 and 47 activate the code for either of the cases accordingly.

The reason that the following (i.e., age-associated retirement) Lines 48, 52 and 56 are left blank in the schedule for the young cohorts (< 4 years) is that it is hard to conceive of the retirement of the young fleet for any age-related reasons (modern trucks are quite sturdy!).

The "Centre" spreadsheet consolidates retirement/re-investment schedules of individual units into the retirement/re-investment schedule on the company level in Lines 24–67 using the SUM-across-the-spreadsheets function introduced in the regional airline case study.

This completes our introduction of the retirement/re-investment schedule for trucks in the model[13]. The schedule is fascinating in that by considering a certain logically limited number of disposal/reinvestment scenarios it lays the flexible groundwork for automating the estimation of future investment costs for the business: the investments are essentially endogenized in the model and result from particular transportation volumes expected to be handled by the business!

Having the centralized retirement/reinvestment schedule assembled in place (Lines 24–67 of the "Centre" tab), most of the rest of the company's PP&E analysis is also carried out on the central level (the "Centre" tab). Lines 70–130 of that spreadsheet develop a "Schedule analyzing Carrying and Disposal amounts (per truck)" for each and every truck cohort—those historically existing in the company (since the first 2017 cohort, being the year when the company inaugurated its truck units) and those expected to arise as a result of re-investments till the last forecast year of the model (the year 2031 cohort). For each such cohort, we develop Gross carrying amounts (Lines 71, 75, 79 …), Annual depreciation charges in Lines 72, 76, 80… (assuming the linear pattern of depreciation to zero residual value over the 7-year period—as per the accounting policies of the entity), Accumulated depreciation (Lines 73, 77, 81 …) and, last but not least, the Disposal value (net of VAT) in Lines 74, 78, 82 … In the Schedule, the Gross carrying amounts (GCAs) represent the average recorded historical accounting figures for each existing cohort (the year 2017–2020 trucks), and inflation-indexed current prices new for trucks (supplied by the MAN dealer as of analysis date) for the future reinvestment cohorts starting from 2021. The annual depreciation charge formulas in Lines 72, 76, 80 … are based on the IF statements to guard against depreciating trucks into the negative territory below their original gross carrying amounts (in the last year of the depreciation process, the depreciation charge is set equal by the formula to the difference between their Gross carrying amount and Accumulated depreciation, even if a greater uniform depreciation charge is being implied under the straight-line depreciation process). Finally, the Disposal value of trucks in particular cohorts (on Lines 74, 78, 82 ...) represents their estimated second-hand market selling price (for the age the cohort would have had in any given year[14]) and is based on the current proportions observed to be holding between the market price new and second-hand market prices for same-model trucks of respective ages[15] (see Lines 3–4).

Schedules in Lines 131–194 (of the "Centre" tab) are the subsidiary schedules for summarizing the developed cohort-wise information into neat separate schedules for Gross carrying amounts, Depreciation charges, Accumulated depreciation, and Disposal values also on a per-truck basis.

The next set of schedules in Lines 195–240 of the "Centre" spreadsheet represents an interaction between the retirement/re-investment schedule discussed above (see **Table 2** for the schedule at a unit level) and the parametric schedules for carrying amounts, depreciation and disposal values developed on a per-truck basis (from Lines 131–194).

In the "Schedule of disposal proceeds from decommissioned trucks" (Lines 196–205 of the "Centre" spreadsheet) we multiply the number of trucks from "−" and "absolute decommissionings" lines of the summary retirement/re-investment schedule (provided this number is negative, i.e., only picking up the actually retired cohorts) by the disposal values the trucks in those cohorts are expected to have in the year when retired. This multiplication process, when summed up across all the retired cohorts, returns the company-level disposal proceeds (net of VAT) expected from selling the retired trucks on the second-hand market (Line 205 of the "Centre" tab). Notice, again, the use of the INDEX functions—this time when applied on their own to retrieve data from a 2D data table (the per-truck disposal value matrix in area D180:N194)[16].

Additionally, when the retired trucks are disposed of, their Gross carrying amounts leave the balance sheet simultaneously with the associated Accumulated Depreciation. So we have to estimate those disposal-related movements of value from the balance sheet and, to that end, the two additional schedules—the "schedule of gross carrying amounts removable from the balance sheet due to truck disposals" (Lines 206–216) and the "schedule of Accumulated Depreciation removable from the balance sheet due to truck disposals" (Lines 217–227)—are developed in the model on the same principles as the "schedule of disposal proceeds from decommissioned trucks". Finally, the total depreciation charges for the company's truck fleet are estimated (in Lines 228–238) based on the cohortal inward migrations across time ("+" lines in the summary retirement/re-investment schedule). Company-level investment costs for trucks are estimated in Line 240 of the "Centre" tab.

This groundwork of diverse combination schedules from Lines 195–240 suffices to develop the summary investment schedule for trucks (in Lines 241–248, "Centre" tab). Notice that in the discussed financial model the end-of-period Net carrying amount balances are arrived at, uniformly, as:

End-of-period Net carrying amounts = Gross carrying amounts – Accumulated depreciation (including for the current year).

This approach to deriving the end-of-period net carrying amounts is meaningful in the context of the current model since we are also interested in exploring the impact of revaluations on some investment schedules in the model (including the ones for the corporate real estate (Lines 742–755 of the "Centre" tab) and current rail assets (Lines 111–137 of the "Current rail" tab). It should be noticed that, whenever we revalue PP&E assets, the accounting system usually records their revaluations as a proportionate increase/decrease in both their Gross carrying amounts and their Accumulated depreciation. For example, the management has decided to increase the book value of the currently existing rail (or truck) assets recorded on the balance sheet (i.e., rail cisterns) by 50% over their current net carrying amounts[17]. So, the revaluation ratio *k* is 50%.

On the asset side, this revaluation will be recorded, as:

$(1 + k) \times$ Original[18] end-of-period Net carrying amounts = $(1 + k) \times$ Original Gross carrying amounts − $(1 + k) \times$ Original Accumulated depreciation.

But if we increase the asset side of the balance sheet by k × Original end-of-period Net carrying amounts without doing anything to the Equity & Liabilities side of the balance sheet, the balance sheet will get unbalanced in the same amount. So, it is a generally accepted practice to attribute the revaluation increment for held-for-use assets (i.e., k × Original end-of-period Net carrying amounts) to the increase in the equity account (see Balance sheet section of the model, Line 651 of the "Centre" tab).

The development of retirement/re-investment schedules and investment schedules for the truck cisterns (in Lines 249–475 of the "Centre" tab) follows exactly the same process as described for trucks.

The model has some auxiliary investment schedules (in Lines 730–777, "Centre" spreadsheet) on top of the major ones for trucks, truck-cisterns and cistern-wagons (Lines 241–248 "Centre" tab, Lines 468–475, "Centre" tab, and Lines 36–45, "Sum Rail" tab[19], respectively). All the investment schedules dealing with the described PP&E sub-categories are aggregated into the single investment schedule for PP&E assets of the Company in Lines 496–505 of the "Centre" tab, which is, in turn, incorporated in the usual way into the Company's balance sheet (Lines 638-660 "Centre" tab) and P&L (Lines 573–619, "Centre" tab) pro formats.

Unlike when modelling freshly initiated investment projects, whose balance sheets start blank everywhere at the commencement date of the projects, the current analysis involves an operating entity so the commencement (entry) balance sheet at the commencement date of the model (01/01/2021) in field C640–C658 of the "Centre" tab is a set non-blank projected inputs (estimated as at 01/01/2021) based on the latest available balance sheet information (as of the analysis date 30 June 2020—in field B640–B658)[20].

3.2.3. Operating revenues and costs of the Company, debt schedules and other structural elements of the model

In line with the structure of the model, the operating revenues and costs of the company are first developed in the segment-specific tabs of the model and then aggregated on the central level (in Lines 507–523 of the "Centre" tab). The associated VAT components of the revenues and operating costs of the company are aggregated in the VAT schedule of the model (Lines 524–535, "Centre" tab), which computes the projected net VAT liabilities of the company having regard to both its operating *and* investment activities (that is, output VAT on truck disposals and input VAT on truck re-investments, also including data from the Rail Invest projects).

- Revenue determination for truck and rail segments

Revenue of the company operating units is estimated in Lines 501–509 of truck segment-specific tabs as a product of the estimated volume of transportation (in tonne-kilometres) and the weighted average transportation tariff currently reported by the units (suitably adjusted for the inflation going forward). For rail operation segments of the model, the revenue from renting out the rail cisterns is the product of the expected daily rental rates and effective wagon-days chargeable in rent (Lines 35-51 of rail segment-specific tabs)[21]. In both operational segments, the revenue is subject to output (sales) VAT.

- Operating costs in the truck segment

Most of the Company's operating costs are borne on the unit level and are of variable nature (with the exception of salaries of unit managers and technicians, parking lot and office rents and miscellaneous office administration costs—which are estimated as inflation-indexed fixed costs without tying them to any volume-of-operation drivers). Diverse variable operating costs of the company estimated in Lines 511–842 of truck segment-specific tabs are mostly tied to a limited assortment of drivers: either the number of trucks expected to be in operation in each forecast period (e.g., with regard to third-party liability insurance costs, cost of truck washes, and vehicle taxes) or their expected average or aggregate mileage in each period (e.g., with regard to truck fuel costs, tire replacements, maintenance costs, and tollways and the road usage tax). Only the insurance costs for the truck fleet are estimated with reference to the unit-level age/quantity structure of the fleet in each forecast year of operations and the associated market values of trucks in those periods[22] (thus, all the hard work of estimating retirement/re-investment matrices (Lines 43–86) and the auxiliary schedules (in Lines 154–263, "Centre" tabs) came in handy not just for projecting the company's investment costs but also some of its variable operating costs). Additionally, Lines 576–629 (for trucks) and Lines 630–680 (for truck cisterns) contain some workings for maintenance costs of the fleet—which are also based[23] on the product of numbers across the three age-dependent matrices: the matrix for the number of trucks of a different age in operation in each forecast year of the model (in Lines 581–592, based on the retirement/re-investment schedule from Lines 43–86), the age/repair costs matrix per 1 km of mileage[24] (in Lines 593–603) and the age/average miles matrix (in Lines 604–614)[25].

- Operating costs in the rail segment and their relation to rail investment schedules

Modelling operating costs in the rail segment is rather straightforward due to the simplicity of the company's operations in this area, i.e., just holding, maintenance and the leasing of the wagons to the parent company at agreed-upon transfer rents (per diem), linked to the market conditions. Here the periodic segment-wide operating costs generally obtain as the product of (inflation-adjusted) unit costs (per wagon or per maintenance protocol) multiplied by the number of wagons currently held and emerging from the set of investment projects/schedules contemplated for the rail segment (unlike for trucks, the rail investment schedules are not dynamic and don't envisage rolling-stock retirements due to the long-term service life of all the wagons—on the order of 25–30 years—spanning beyond the forecast period of the model).

Broadly, operating costs in the rail segment are split between insurance and maintenance costs. The insurance costs (i.e., annual insurance premia in Line 56 of rail segment-specific tabs) are based on the insurable value of the wagons (which is the higher of their accounting net carrying amounts *or* a certain minimum insurable value threshold—see Line 117 in the rail segment-specific tabs). The repair and maintenance costs of the cistern wagons summarized in Lines 272–283 of rail segment-specific tabs depend on their type (whether intended for the carriage of petrol, LNG or acid products) and are based on the product of the number of cisterns undergoing servicing in a particular forecast period of the model[26] and the associated unit costs of particular maintenance protocols[27] (Lines 169–202 of the rail segment specific tabs). The reader may refer to the detailed inventory of those costs to glean information about conventional maintenance routines to be followed for the 1520 gauge operations of cistern wagons.

In terms of commissioning of the new wagons over the forecast period of the model, notice the crucial difference between Rail Invest 660 and Rail Invest 850 projects in the rail segment-specific tabs: Rail Invest 660 represents an ongoing investment project, therefore, its investment schedule (through fields C154–164) contributes non-zero amounts to the commencement balance sheet of the company in the model. Rail Invest 850, on the other hand, is an investment project with investments in it to be incurred after the 01/01/2021 commencement date of the model (thus, field C154–164 in the "Rail invest 850" tab is all blank). "Current rail" spreadsheet records projections for the company's rail operations arising as a result of past investment projects (from the early 2000s). Thus, the past-, present- and future-tense investment projects co-exist in the model harmoniously. To reiterate, this model is not just a model of some future investment project but rather is a comprehensive attempt to model/value an ongoing business as an assemblage of the past, present and anticipated future investment projects.

- Debt financing schedules of the model

Notice the structure of the debt schedules in the model (on the "Debt" tab). As can be seen, the company has existing debt (recorded in Lines 34–92 of the "Debt" tab) and plans to raise the new one in order to fund its current and future rail investment projects (Lines 93–158 of the "Debt" tab). The basic pattern of debt repayment—both actual and assumed for all the future loans following the analysis date—is "amortization in equal instalments" (thus, the PPMT function is employed in all the debt schedules to estimate current equivalents of the capital amounts). However, the debt schedules also allow increasing equal instalments associated with debt repayments according to certain voluntarily-chosen multiples (Lines 36, 44, 52 ... etc. highlighted in orange colour for each respective debt schedule). The case of multiples[28] set to "1" illustrates the plain debt amortization in equal installments at a given interest rate (the baseline debt scenario of the model). But if those multiples are set to some value other than "1", whatever the PPMT function returns will be multiplied by the value of the multiples. This refinement in the schedules is a suggested tool for accommodating the management's request to explore accelerated patterns of loans' repayment compared to the baseline debt scenario in the model.

Also notice the use of IF statements in conjunction with PPMT functions in the debt schedules (in Lines 39, 47, 55 etc.). Especially against the backdrop of non "1". Accelerated loan amortization factors, the IF statements are needed as an automatic safeguard in the schedules in order not to overshoot the debt amortization into the negative territory in the last period of debt repayment (outstanding loan principal can never be negative). The impact of all the current and future loans on the model is summarized, in a simple additive way, in the summary debt schedule of the model in Lines 159–165 of the "Debt" tab (aggregation of debt schedules is no different from the aggregation of investment schedules in this respect). Additionally, it should be mentioned that, as of the analysis date, it is known that the company shareholders will have contributed some new equity by the model commencement date (01/01/2021) in order to fund the rail investment projects partially out of their own funds. The expected amount of their contribution is reflected in the commencement balance sheet in cell C650 on the "Centre" tab.

Finally, pay attention to the "Assump and output" tab, which is meant to serve as the main operational dashboard of the model. Here in orange-brown colour we highlight all the crucial numerical assumptions of the model which stand either for policy variables (including the Accelerated loan amortization factors (Line 6), revaluation multiples (Cells D70, D72), dividend payout ratio (Line 76)) or represent uncertain key inputs to which it is clear that the model is particularly sensitive (such as expected inflation rates for fuel and other costs (Lines 9–39), maximum service mileage for the trucks (Cell C112), the discount rate for FCFEs (Cell N5) etc.). The user can adjust these inputs to explore their impact on the final outputs of the model.

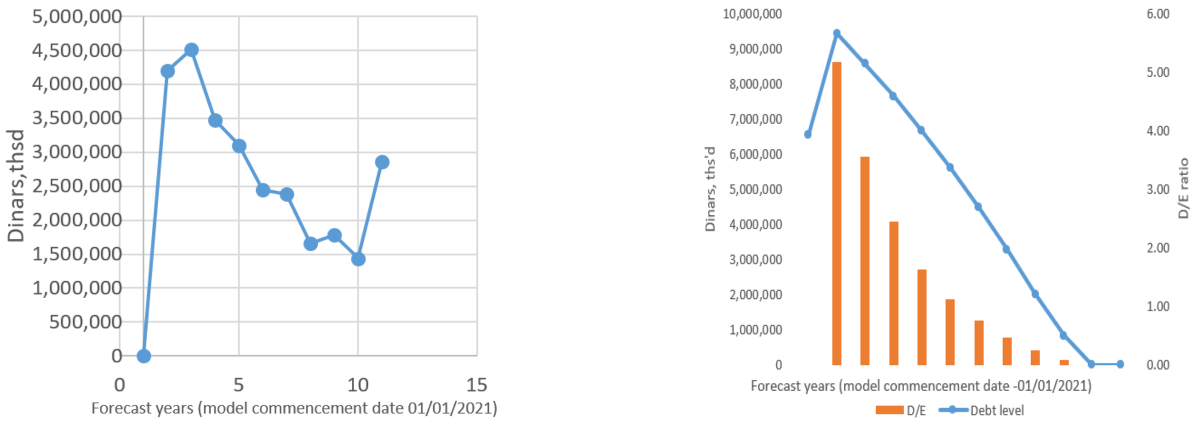
3.3. Model calibration

The model has been calibrated in terms of its operating sections by having regard to the company's annual budget for FY 2019/2020. The key calibrating parameter was the average speed on route. Minor adjustments to it within realistic ranges have resulted in an almost complete match with the actual transportation volumes for the calibration period and an exact match in the number of trucks needed on a unit level vs. the actual trucks in active service in the unit at the start of the model.

4. Discussion of modelling results and limitations of the analysis

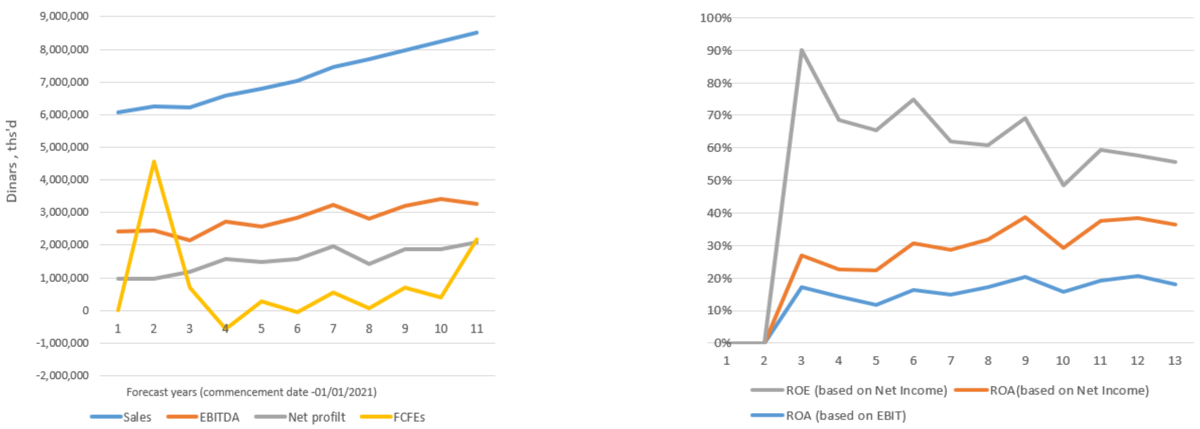
The model provides a valuation of the company's business as a going concern, as of the model commencement date 01/01/2021, having regard to the ongoing and future investment projects. The valuation is rendered on the basis of 100% equity value under the direct approach to cashflow derivation in Lines 678–688 of the "Centre" tab and relies on the discounting of FCFEs (estimated in Line 679[29]) at 20% equity discount rate (as determined by the parent company) with the terminal value capitalized under the Gordon model and based on FCFE for the Year 2031. The nominal growth rate for FCFEs implied in the Gordon model is 4% (Cell N680) which is close to the long-term inflation rate assumed (thus, we use zero long-term real growth assumption for the cashflows). The present value of the terminal value contributes not a too significant share (about 20%) to the 6.5 bln. dinar final valuation for 100% equity of the business[30] (cell C687), given the long-term forecast period of the model, so the final equity valuation result is not too sensitive to particular assumptions selected for estimating the terminal value of the business[31].

Apart from the most likely valuation of the company's business, other key outputs of the model most relevant for management decision-making on the "Assump and output" spreadsheet are the period-by-period ending cash balances (Line 7)—to see if any cash deficit is likely to arise in the business over the forecast period and, thus, if any new loans will be needed (Cell P7). The trend in cash balances and other key financial outputs of the model, such as the profitability ratios, are plotted on panels in **Figures 3** and **4**. As we can see, at the policy dividend payout ratio of 40% (Line 76) no cash deficit is likely, and comfortable cash balances, as illustrated by the sparkline inserted in Cell B8, will be in evidence instead[32]. However, should the management use the company as a 'cash cow' and decide to pay dividends on the order of, say, 80%, such a policy would clearly be unsustainable and create huge cash deficits. The issue of whether the dividend payout policy affects the equity value of the business (NPV of its FCFEs) is a hot-button issue in Corporate finance (the so-called debate on "dividend irrelevance") (Damodaran, 2014). In the context of our case study, the model can answer that question specifically, using the generally accepted financial modelling principles (however, only subject to the (very restrictive!) assumption that the discount rate for FCFEs won't be affected by either the dividend payout policy or the capital structure of the company)—we can just change the dividend payout ratio in Line 76 ("Assump and output" spreadsheet) and see how it affects the equity value of the business (Cell P5) provided the model remains feasible (no "cash holes" in Cell P7). One of the manifest effects of a slight non-neutrality of the dividend policy is due to the fact that interest-generating idle cash balances change due to variations in the dividend policy and, in situations when the shareholder's rates of return[33] and the depositary interest rate for idle cash balances are different in the model, this inevitably affects the equity value of the business to some extent.



(a) **(b)**

Figure 3. Projected cash balances and debt for the case study enterprise. **(a)** forecasted cash balances for the enterprise; **(b)** long term debt load for the enterprise.



(a) **(b)**

Figure 4. Major output charts the developed financial model. **(a)** FCFE cash flow and accruals (Revenue, EBITDA, Net profit projections for the business) in nominal dinars; **(b)** Financial ratios of the business.

Other outputs of the model relevant to decision-making include all the 3 statements of the model contained in the "Centre" spreadsheet (P&L in Lines 573–619, cash flow statement in Lines 537–572 , and the balance sheet in Lines 638–660), the associated financial ratios (Lines 672–677), and some physical operational parameters of the business having to do with the transportation volumes tracked by managers (Lines 661–671).

One is able to explore, additionally, the impact on the model outputs of re-valuations for the company's real estate and the rolling stock (changing cells D70 and D72 on "Assump and output" spreadsheet), as well as that of accelerated debt repayments (changing Line 6 inputs). The management was interested in knowing about these matters while commissioning the discussed financial model.

The modular structure of the model with truck-specific and rail-specific spreadsheets aggregated at the central level, and the use of calibration parameters—make the model amenable to multiple modifications. With suitable modifications, it can be used in most of the situations for diverse public and private transport infrastructure enterprises employing truck, bus and/or rail fleets for the carriage of bulk cargo quantifiable by weight (or fare paying passengers) on a network of set, but modifiable, routes[34]. The 3-statement structure of the model means that it will be able to answer many questions about investing, financing and dividend decisions simultaneously, whereas its focus on business valuation aspects lends itself to further extension in the context of accounting for impairment testing, where each segment-specific spreadsheet can represent a separate cash-generating unit and used to determine its value-in-use.

Limitations of the analysis:

External factors that can limit the applicability of the model are generally associated with the difficulty of forecasting long-term, specifically with respect to prices and investment and operating costs. To confront the problem, the model provides—on the "Centre" spreadsheet under the assumptions section a set of time variant inflation indices for different types of revenues and costs. While the model doesn't make those indices stochastic, but uses their expected values, they can be randomized using the standard random number generation and Monte-Carlo procedures in Excel.

With respect to the investment decisions affected by depreciation, the model relies on a fixed pattern of market depreciation in the value of trucks (i.e., on percent good factors as being ascertained at the date of analysis only), whereas this market pattern can undergo changes over the forecast period of the model. Last but not least, same also applies to the dependency of repair and maintenance costs of trucks on their age: While this dependency was calibrated on the available enterprise-level data based on the fleet up to 5 years of age, there are units in the model with lesser intensities of truck use where trucks/tankers can stand in service up to 9 years before reaching the uniform retirement mileage of 900,000 kms. How the dependency of maintenance costs on age stretches for trucks in such outlier units is not very clear[35], because it is a combination of both mileage and age that bears on the problem, and so the assumption of close to linear but flattening dependency of the costs on age was utilized for such extreme ages, as is supported, e.g., by Artemenkov et al. (2023), Goryaeva and Goryaeva (2012), Sime et al. (2020)—see **Figure 5**.

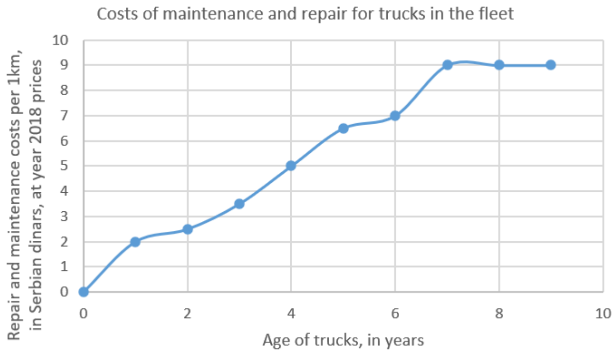


Figure 5. The dependency of unit maintenance/repair costs for trucks per 1 km of mileage on their age, in Serbian dinars (based on the ratio: 1 service year = 180,000 kms).

Issues of misalignment and poor linkage between the operating needs and the available fleet are not prominent in the context of the model since, backed by the contracts with the parent company, tankers leave refineries full to distribute the fuel on the way, so their capacity is predictably and almost fully utilized, with only minor allowances made for spare capacity of the fleet in case of occasional breakdowns. However, in other transportation contexts the systematic factors of underutilization and operational redundancy have to feature more prominently in the analysis.

5. Conclusion

This case study provided an example of a structured 3-statement financial model for a big transportation business with multiple operational units and planned investments. It offered a dynamic algorithm for endogenizing truck replacement and expansion investments tying them to the operating activities of business units. It also showed how to incorporate accelerated debt repayments and asset revaluations into the modelling process. We believe this real-life case study cuts into the actual nitty-gritty of the financial modelling business and reflects its justified complexities as closely as possible. Further research effort should be made ongoing on calibrating some sensitive operating costs of the model, such as unit maintenance costs for trucks depending on their age and mileage, especially because the newer generation of trucks is not only more fuel economical, but also may have a de facto different maintenance cost as they age (Kodjak, 2011). This can also affect the depreciation pattern (percent good factors) for trucks of the older generation as long as they last in service.

Author contributions: Conceptualization, AA; methodology, AA; software, AA; validation, AA; formal analysis, AA; investigation, AA; resources, AA, OG and MM; data curation, AA; writing—original draft preparation, AA; writing—review and editing, AA, OG and MM; visualization, AA and MM; supervision, AA and OG; project administration, AA and MM. All authors have read and agreed to the published version of the manuscript.

Data availability: Link to download the referenced case study model in Excel is given below: https://disk.yandex.ru/i/auLPzXNKMzgVmg

Conflict of interest: The authors declare no conflict of interest.

Notes

1 Usually the nearest regional refinery is chosen for deliveries and the delivery patterns and volumes generally hold stable over long periods of time. Since the model is an annual frequency model, we are not interested in seasonal variations in fuel demand and, consequently, in seasonal variations of demand for the fuel transportation services.

2 "Tonne-kilometre transported" is a standard volume of service output in logistics industries associated with transportation of freight.

3 This parameter is written into the delivery contract for every petrol pump and roughly signifies a one-way distance, by road, between the refinery and the pump.

4 The Company's policy is to retire (dispose of) the old trucks by selling them on the secondary truck market in Serbia once they reach the mileage of 900,000 kms. In fact, the market for such worn-out trucks exists in Serbia, and the dependency of the truck selling prices (as a% of price new) on trucks' age and mileage is presented for the model in question in area Q1:T12 of the "Centre" spreadsheet in the model. The retired trucks can still be sold for 20%–25% of their original price new. So, notice, therefore, that the disposal of old trucks generates cash proceeds, and maybe even income, for the company that needs to be accounted for in the model. After all, trucks, cisterns and rail cistern-wagons are, and will be, the major balance sheet items of the company and their depreciation schedules are to be modelled explicitly.

5 As the company has developed the truck segment relatively recently and grew it fast, it still has no experience with its fleet replacement policies—and the extent of their impact on dividends and financing—so the financial model is also meant to contribute to resolving that question.

6 The modelling process is facilitated by the fact that the company is incorporated as a single entity with a single reporting balance sheet, without any formal stake-holdings in subsidiaries.

7 The tonnage increases slightly over the forecast period of the model (up to 24 tonnes)—as the older truck cisterns in the fleet get replaced by more capacious modern designs. Also notice that the densities of petrol and diesel products are slightly different and each cistern has 3 compartments for each type of products. But it is hard to convey all the analysis that went into developing this financial model.

8 Usually, one region (i.e., catchment area of each company unit) is supplied from a single refinery.

9 Where inward migrations are marked in green highlighter and are found in "+" rows because they add to the count of trucks of that age, whilst outward migrations are marked in red and are recorded in "−" rows.

10 but from the cohort aged 1 year less than the retirement age as per the workings of the developed algorithm. Reasonable considerations of spare capacity can be additionally addressed outside of the algorithm being described. For example, the biggest regional unit in the model with the operational need for about 60 trucks also has 2 trucks in reserve to deal with any breakdown situations and scheduled servicing needs.

11 The oldest cohort, it should be remembered, is always retired in full (second-hand market disposals = inward migrations for the last year of this cohort), because the old trucks are physically worn and incapable of any further service on economic grounds (Artemenkov et al, 2023).

12 The two data strings are structurally aligned, e.g., by virtue of being the members of a bigger organized data-set structure, in our instance the 2D retirement/re-investment schedule.

13 The analysis of retirement/re-investment schedules for truck cisterns on Lines 273–322 of the truck segment specific spreadsheets is exactly the same.

14 Not that the trucks are actually meant to be disposed of at the indicated disposal price every year (since a cohort is only retired once upon reaching its designated retirement age).

15 As per the conducted market survey in Serbia for the analysis year (2020) subject to the intensity of use adjustments—see Lines 3–4 of the "Centre" spreadsheet.

16 The INDEX (2D DATATABLE ARRAY; X; Y) function returns the value of a datum at the intersection of Xth row and Yth Column in the 2D DATATABLE ARRAY. Here we use this function on its own without combining it with MATCH.

17 Let's say, this is done in order to bring net carrying amounts of the assets on the balance sheet in line with the current market values for those assets (that might have grown from the moment the assets were first recorded on the balance sheet due to inflation) and thereby increase the capitalization of the balance sheet (and, potentially, the company's equity on the stock market).

18 Original in a sense of one recorded before undertaking the revaluation exercise.

[19] The summary investment schedule from "SUM rail" spreadsheet is also reproduced in Lines 487–494 of the "Centre" spreadsheet.

[20] The reasons for the mismatch between the model's commencement balance sheet (as at 01/01/2021) and the latest available balance sheet (as of 30/06/2020) are explained in a comment to Cell C659.

[21] There is a difference between the potential and effective "wagon-days in rent" which is associated with the need to maintain, service and regularly overhaul the rail cisterns according to set operational protocols (with unit costs as recorded in Lines 169–202 of the rail-segment specific tabs). Obviously, the wagon lessees are not to be charged in rent for days when the rolling stock is undergoing servicing/maintenance works or is subjected to the major overhauls. Estimates for Wagon-days in Disuse due to maintenance and repairs are provided in Lines 286–357 of rail-specific segment tabs.

[22] This is because the insurance company charges annual insurance premia on trucks as a fixed percentage of their market value on the second-hand market (which is age-dependent and is estimated in the model in our liquidation values matrices—Lines 202–217 of the truck segment specific tabs).

[23] As seen in Lines 615–626 (for trucks) and Lines 666–679 (for truck cisterns) in truck segment-specific tabs.

[24] The Company maintains company-level statistics on the dependence of the average repair and maintenance costs on the age of its fleet, which was proportioned to a per-kilometer basis given the average annual mileage of its trucks.

[25] Since we neglect the impact of breakdown-associated downtime on truck mileage with respect to trucks of a different age, all the numbers in the latter matrix are the same.

[26] As reported in Lines 203–236 of the rail segment-specific tabs according to the management forecasts from the rail unit.

[27] see Lines 169–202 of the rail segment specific tabs.

[28] Which, according to their function, can be called "Accelerated loan amortization factors".

[29] The mid-period discounting convention is assumed (Line 683). Notice that the constant discount rate (of 20%) is used despite the fact that the capital structure of the company changes—as evidenced by the equity and liability section in the Company's balance sheet proforma (Lines 638–658, "Centre" tab) and select financial ratios (Line 673, "Centre" tab). This Modigliani and Miller Proposition 2 contradiction is, of course, something that a quality financial model shouldn't overlook.

[30] That is, NPV (FCFE) to use the language of investment project appraisal, instead of the language of business valuation.

[31] The most attentive of readers must have noticed that the terminal value, obtaining as of 31/12/2031, should have been discounted by 11 years, not 10.5 years, to provide a more accurate estimate of the present value of the terminal value.

[32] With such a dividend payout policy of 40%, the business manages to pay off its debt in full by the end of the forecast period and transition to 100% equity funding for the capital structure on its balance sheet (see Line 654 of the balance sheet proforma in the "Centre" tab) (Eng truck and rail, n.d.).

[33] i.e., the equity discount rate.

[34] The authors also used the same modular structure recently to develop a financial model for a regional airline operating scheduled routes (see Artemenkov, (2023)).

[35] Because the enterprise doesn't yet operate trucks aged 9 years in its fleet, there is no statistically sound record of maintenance costs for such trucks in the enterprise ERP.

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