Russian railroad transport within the historical military cargo delivery system

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Abstract. The paper analyzes the principal factors of influence that shaped up the railroad industry as a key component of the Russian transport system in the early 20th century. The relevance of this research consists in its demonstration of the correlation between the development of a railroad network and particular events that accompanied the accumulation of resources by the Russian industrial society. The state involvement in transport business operations and railroad construction was deeper in Russia than in other European countries. Its influence made a positive impact on the Russian military transportation system in 1914 – 1917. This was the time period when the Russian school of locomotive building was established. This research has practical significance, as it helps to identify the factors that impact the development of railroad transport in the 19th and 20th centuries. The author has employed a method of retrospective analysis of sources (mainly those covering the history of locomotive building in the years of World War I), a comparative historical method, methods of analogy, deduction and induction.

1. Introduction

The demand for railroad transportation turned particularly pressing when the industrial society emerged in Eastern and Central Europe. The demand for a high-quality railroad network went up in the context of military conflicts, that caused the consumption of strategic resources to go up exponentially. Troop movement speed became a decisive factor of military success. Despite the predominantly peaceful and nonmilitary nature of problems, solved by the railroad transport, railroads were acknowledged “a new and indispensable type of weapons used against the enemy” [1]. We know that the construction of steel railroads turned particularly intensive in the second half of the 19th century, after the 19th of February, 1861. The recently published cyclopedia of railroads says that “the abolition of serfdom set the stage for the countrywide railroad construction” [2] [3]. In the 60s and 70s of the 19th century, railroad construction was initiated by M.Kh. Reitern, Minister of Finance of the Russian Empire, who had the intention to organize the delivery of the Russian bread to consumers in Western Europe and to fill the Russian treasury with cash. Indeed, Russian grain, linen, timber and milk products were delivered to major trade centres, including Moscow [4]. A contemporary historian makes a point that in 1890 – 1914, cargoes were composed of raw materials, delivered from the Ural region and Siberia [5], and industrial products, including agricultural machinery, construction materials, equipment and even automobiles, and the share of these products in the structure of railroad cargoes went up.

We analyze the time period, preceding the construction of railroads, railroad stations, locomotives, needed to transport passengers and cargoes, to identify the pattern of the present-day development of
the transport system [6] [7]. The awareness of the railroad transport development in the past enables us to outline a plan for the restructuring of the railroad transport industry and to develop its reformation roadmap in the 21st century [8]. The mission of this research is to reconstruct the timeline of transport development events in Russia.

The objective of this research project is to identify the historic events that influenced the development of railroads and boosted the design and mass production of steam—powered locomotives in the early 20th century.

Hence, the subject of this research is the Russian railroad transportation system and the locomotive building industry that date back to the outset of the 20th century. The research is focused on the relationship between transport and railroad building industries in 1914 – 1917, historic events and transformation of the public demand.

2. Materials and Methods

In this article, the author analyzes the influence produced by political and socioeconomical events of the early 21st century on the evolving railroad transport; invention and further mass production of transport vehicles needed for Russia’s economy. Therefore, principal methods of research include the retrospective analysis of sources, the study of the events that preceded the emergence of the transport policy in Russia, the analysis and generalization of transportation statistics, a comparative historical method, as well as such general research methods as induction, analogy, and deduction.

In particular, the author addresses the works on the history of the heavy industry, metal working and transport (for example, one can address the review papers mentioned in [9] and [10].

3. Results

3.1. Railroad transport and its use. The background

In the first decades of the 19th century, Nicholas I, Russian Emperor, appreciated the use of railroads for military purposes. Railroads could be used to bring troops to the capital from the centre of the country within several days. Railroad stations were used in the same way: in 1849 the Petersburg railroad station was built in the Kalanchev field in the ancient Russian capital; in 1862 the Severny railroad station was built, in 1870 the railroad station was erected in Brest, in 1900 – in Saratov, in 1901 Vindavsky railroad station was built, Boutyrsky station was finished in 1902, and the restructured Yaroslavsky railroad station was commissioned in 1904. The construction of railroad stations was also intensive in St.Petersburg. The Moscow railroad station was the first one commissioned there (with first trains to arrive as early as in 1942). Since then, railroad stations were built all over the country [11] [12]. Railroad stations promoted Moscow as a major railroad hub and a military facility.

Nicholas I believed that a railroad was an instrument that facilitated a quick response to events similar to the Polish revolt of 1830 – 1831. It was no coincidence that the first passengers of the railroad trip from St.Petersburg to Moscow were officers and lower ranks of the guard regiment. Naturally, the second railroad line, built in Russia, was the one that connected St.Petersburg and Warsaw. During the Russian-Turkish (1877 – 1878), Russian-Japanese wars and in the days of WWI, Russian railroads successfully delivered enormous amounts of military weapons, technical equipment and numerous personnel. Transportation was intensified thanks to high professionalism, persistence, patriotic upsurge, and high discipline demonstrated by the railroad personnel. It was a deed of arms and a labour feat art the same time. In the near-front zones and areas of battles railway workers, officers and lower ranks of railway troops were killed along with the military.

The transfer of railroad ownership to the state brought positive changes. In the first decade of the 20th century, the state took over several key strategic railroad arteries. Back in 1917, 70% of the Russian railroads, whose total length was equal to 70,900 kilometers, was state-owned (figure 1).
Comprehensive support, provided by the state, made a positive impact both on the condition of railroads and the industry as a whole. This fact was mentioned in 1907 – 1908 by Count S.Yu. Witte, Chairman of the Council of Ministers of the Russian Empire: “Over a period of forty years… railroads achieved tremendous success. If we compare railways, railroad stations, and particularly steam locomotives and cars, produced back then and now, it turns evident that the success of railroads is enormous.” New items of railroad machines, commissioned after WWI, and infrastructure developments will be discussed further in the article [13].

3.2. Railroad transport and its use. The background

World War I posed a grave challenge to the rear area, although it turned out to be a development driver for its economy. The wars of the first half of the 20th century introduced the notion of “dual-use industrial technologies.” Indeed, in particular industries, the boundary between nonmilitary and military economies was hardly discernible. Demands of military and nonmilitary industries were satisfied by the railroads. It is assumed that the transport logistics of the Russian empire failed the exam of the war. The delivery of food and troops was completely disorganized, and it made a negative impact on the overall national defense potential, as well as the state of affairs at the front and in the rear area. According to one contemporary researcher, “Russia was not ready for World War I in the context of the age of industrialization due to the processes of industrial modernization, which were still underway.” M.I. Tougan-Baranovsky, an economist and a witness of these events, thought that the economic crisis, that outbroke in the days of the war, was caused by transport problems. “The war hampered the delivery of cargoes across the country; it caused unrest in the lending sector and it forced the labour force to discontinue production activities, thus, causing the production output to shrink,” that’s what he wrote in 1915. Indeed, railroads accumulated cars full of ammunition, while artillery troops fell short of shells, rifle units fell short of bullets, etc. This shortage was mainly caused by the legislators, or those members of the Russian parliament, who initiated a political campaign against their government on the eve of the upcoming military disaster of 1916 – 1917. Right before the outbreak of the war, the opposition appealed for peace, voted against military budgets, and weakened Russia’s defense capacity amid escalating military operations. Such was the conduct of the 59 deputies of the fourth State Duma, who belonged to the constitutional democratic party (“kadets”) and voted against the budget of law enforcement authorities at the second Duma session. It was only after the outbreak of the war, when the efforts of the front and the rear were to be mobilized, that the constitutional democrats gave up this strategy. It was by no accident that Professor N.A. Vassilyev (Kazan), an insightful logician and political philosopher, described the behaviour of the Duma liberals by the following aphorism: “They wept at christening parties and had fun at funerals.” That’s the best way to describe their behaviour!
Long before the outset of the 20th century, Savva Ivanovich Mamontov, a major railroad builder, entrepreneur and philanthropist, and Fedor Vassilievich Chizhov (1811 – 1877) proposed to connect major deposits of natural resources by railroads and to loop the main transport flows in the country. Later, local merchants and industrial elites got involved in railroad construction [14]. Pursuant to the roadmaps, developed by railroad engineers in the 19th century, railroads should have connected the White and the Back seas. Back then, a railroad spur was built to facilitate the delivery of cargoes and transport passengers from the Donbass area to the shoreline of the Azov sea. Another railroad connected Moscow and Arkhangelsk, or the capital and the White sea shore. The construction of trans-regional railroads was highly expensive. Instead of 20 million rubles, provided from the budget, a double amount was spent. The expenditure was proclaimed inexpedient in the days of the war, when railroads leading to the West were blocked by the fronts. The railroad spur to Arkhangelsk was used to deliver supplies provided by Russia’s allies. The situation was the same in the days of WWII. However the magnitude of railroad construction turns clear if we mention the following fact: during the last seven years of the 19th century, Russia built 2.6 thousand kilometers of railroads; during the Soviet and post-Soviet period the country had no chance to match the intensity of railroad construction. Thanks to foreign investments, by the beginning of WWI 35 of 50 thousand versts of railroads, or 70% of their total projected length had been built. At the outset of the 20th century, Russia got 1.5 billion gold rubles for this project [15].

4. Discussion

4.1 Roadbuilding problems in the early 20th century

Let’s switch to controversial roadbuilding issues.

Despite the government efforts, Russia’s transportation system remained incomplete and unsafe if challenged by any war actions. For example, the government failed to finish the construction of the Murmansk railroad on time, although this spur should have connected the capital of the Empire with the northernmost though unfreezing port. Therefore, ammunition and other supplies, provided by the allies, were delivered irregularly. Nevertheless, railroads, built before the war, were used to transport a huge amount of cargoes in 1914. Concerted efforts of cargo handlers as well as the availability of a sufficient number of locomotives and cars ensured the success both at the front and in the rear.

The organization of railroad communication contributed to this success. To improve the capacity of particular railroads, their managers launched a flexible policy of instruction execution. If needed, they sent locomotives one after another, without waiting for the line to be clear. This know-how was first applied by S.Yu. Witte, a future minister of finance, who served as the general manager of South-Western roads. By declining the services provided by dedicated teams, railroads switched to the so-called “American” or “shift-based” system, when one locomotive was serviced by several teams of technicians at a time. This measure extended the 24-hour mileage per locomotive.

4.2. The “Golden age” of the Russian locomotive building industry. Problems that accompanied the establishment of the Russian school of locomotive building

In the meantime, the state of affairs could have been even worse but for the design and production of railroad cars in the first decade of the 20th century. In this section we will analyze the technical fit-out of railroad vehicles in the days of WWI.

WWI set the following objectives: continuous supply requested more powerful steam locomotives and more sophisticated railroad cars. Therefore, four-axle steam locomotives, widely spread before the war, turned out insufficiently strong. As early as in 1909, V.I. Lopushinsky, an outstanding Russian designer of locomotives, acting together with M.E. Pravosudovich, designed and developed a five-axle steam locomotive that was totally different from other widely spread locomotives belonging to “SCH” and “O” series (“SCH” locomotives were designed on the basis of the concept developed by engineer Schukin, while “O” locomotives were entitled “osnovnye”, or the main ones, and the first letter of this word served as the title for the whole series of vehicles). Steam locomotives designed by Lopushinsky...
and Pravosudovich replaced those five-axle locomotives that had been brought from the USA, as they were hard to use in the Russian climate. American locomotives loosened the railroad, and their operation turned out to be extremely expensive. The steam locomotive, designed by the Russian engineers, had an axle formula of 0-5-0. Its supply was initiated in 1912, and it immediately joined the process of delivery and proved its competitive strengths. In the years of WWI, mass production of these steam locomotives was organized.

What is the structural strength of the invention made by Lopushinsky?

In the 20th century, the capacity of locomotives was driven by the amount of burnt fuel in a unit of time. The best position of an effective furnace was outside of the frame and driving wheels. Boilers with spacious furnaces were used before the war and in the days of the war in Russia to boost the capacity of steam locomotives. Therefore, the axle of the Lopushinsky’s locomotive was placed a lot higher. One should appreciate the wit of Pavel Petrovich Melnikov (1804 – 1880), a railroad engineer and developer of the theory of railroad transportation in our country, who insisted on locomotive dimensions different from those in Europe. In the 20th century, these dimensions proved their unbeatable strengths, as they were perfect for designing high-capacity locomotives suitable for Russian railroads.

We can make a paradoxical conclusion that the pre-war period as well as the first years of military operations were “the golden age” of the Russian locomotive industry, although the war itself was lost. An illustrated dictionary of railroads has several entries in which information on Russian railroad engineers is provided: “Russian locomotives looked slender thanks to their height and proportionality. Their appearance was designed by talented engineers, who worked with true inspiration, but it was based on dimensions developed by Melnikov.” Here is an example of advancements made by the Russian locomotive industry during WWI. In 1916, a steam heater was designed for the “O” series locomotive. The steam heater was designed by M.P. Pokrzhivnitsky, who placed it over the cylindrical part of the boiler. This steam heater was nicknamed a “compact” one. In 1915, O locomotives were supplemented by O2 locomotives, and the list of similar examples can be never-ending. In these tough times, “locomotives, designed in Russia, had a binding appearance.” Their performance (the speed of a locomotive designed by Lopushinsky reached 65 km/h) was boosted by their proportionality, and the synergy of their boilers, steam engines and underframes. “E” series steam locomotives are in operation now, in the 21st century; they are used by travel agencies as vintage vehicles designated for tourists. These locomotives were highly durable for the following reasons: “the secret of their durability is not the simplicity of their construction (although this feature is a vital driver of success), rather, it’s their universality and extensive applicability” [16].

In the years of WWI, major Russian factories launched mass production of “E” series steam locomotives that had five principal driving axles (the total of 11,000 steam locomotives of this series were manufactured in the 20th century). The number of driving axles boosted the capacity. However so-called “E-series” locomotives were the principal railroad vehicles not in the days of WWI, but during WWII. Super-powerful locomotives, designed in the Soviet period, whose axle formula read as 1-5-1 and 1-5-2, built in the 30ies through 50ies of the 20th century, represented re-designed “E” locomotives. Contemporary historians, specializing on the history of the railroad transport, use metaphors when describing the strengths of “E” locomotives. L.L. Makarov drew attention to their universality: “The importance of “E” series locomotives, or “echo locomotives”, as they were lovingly nicknamed by mechanics, reminds the one of a horse, although this horse is made of iron.” This horse endured the terrible wars of the 20th century, let alone its ambitious construction projects. More “sophisticated” machines were unable to move, if they replaced these undemanding vehicles. “E series” locomotives turned out a typically Russian undertaking: it was simple and consumed any fuel. It is resilient, enduring and reliable, as a hard-working and simple-minded worker. It is multi-functional.” [16]

A super-heavy steam locomotive, that had the axle of 1-5-1, was manufactured since 1931 by the Lugansk factory, in furtherance of the order placed by the Joint State Political Directorate (this series is labelled “FD”, and the abbreviation stands for Felix Dzerzhinsky). The mission of this model was to
substitute Lopushinsky’s locomotive. The axle load of the new locomotive reached 20 tons, and its capacity was equal to 2,500 hp. However, its performance fell short of the expectations; therefore, the production of “E series” locomotives was resumed. During WWII “FD series” locomotives traveled in the rear areas, where rails were strong enough.

4.3. “Sheep” (“O” models) and “Jackfish” (“SCH” models)

Let’s take a look at other series of steam locomotives used in 1914 – 1917. The legendary “Sheep” model, intensively used in the hard days of the war, was a predecessor of the series of five-axle steam locomotives designed in the 20\textsuperscript{th} century. Its request for proposal and design was developed by V.I. Lopushinsky, who served as the railroad engineer at Vladikavkaz Railroad Management Department. During WWII, 8,000 locomotives of this model were in operation (see Figure 2). Not without reason this model obtained letter “O” in its name (that stands for “the main one”) as early as in 1912. Five years before the commencement of WWII this locomotive demonstrated simplicity, reliability, convenience and an extensive safety margin (which turned inestimable during the war). During WWI, these locomotives were converted into armoured vehicles. “O” locomotives remained in operation through the 60ies of the 20\textsuperscript{th} century, and some items are still in operation in the 21\textsuperscript{st} century. These were the very first models that took account of the features of Russian railroads. Heavy loads taken back and forth required high capacity engines, although rails were not strong enough. Long railroads limited the set of instruments used by a designer of locomotives and caused extraordinary specifications to be developed for the new locomotives. As far as we can see, these specifications couldn’t be implemented by producers of locomotives in Europe and the USA. Therefore, in the early 20\textsuperscript{th} century, technical specifications of locomotives needed to be customized to Russia’s climate and terrain. That’s how the locomotive industry developed in Germany, UK, France, USA. The Russian school developed in the same intensive manner.

The history of the most popular steam locomotive of the early 20\textsuperscript{th} century, which was nicknamed “a sheep”, dates back to the 80ies of the 19\textsuperscript{th} century. In 1889, Vladikavkaz railroad directorate fell short of freight locomotives that had four couples of power-driven wheels; therefore, it placed an order with the Kolomensky machine building factory for the production of 30 steam locomotives that had 0-4-0 axles, each equipped with a compound two-cylinder steam engine. The new model replicated the prototype, or a “CH” series model from the so-called “government reserve”. First ten steam locomotives, ordered by Vladikavkaz railroad directorate were supplied in 1890, and in 1891 forty more items of the kind were manufactured.

In 1912, locomotives belonging to most widely used series, manufactured in the 1890ies, were labelled “O” - locomotives. They could get the title of O\textsuperscript{4} or O\textsuperscript{D}, where a low-case letter meant the type of a mechanism. Soon locomotives belonging to “O\textsuperscript{km}, “O\textsuperscript{m}, “O\textsuperscript{h}, “O\textsuperscript{m}, “O\textsuperscript{m}” series were designed and produced. In the same year, the manufacturing of “O\textsuperscript{m}” locomotives was initiated, and later they became the most widely spread locomotives in Russia. They had a Walschaert valve gear installed.

V.A. Rakov, a railroad transport historian, is convinced that it was the series of locomotives designed by professor Schukin that ousted the “O” series (the “sheep”) from the market, which was later used by minor railroads and railroads maintained by industrial enterprises.

The basic regularity that accompanied the development of Russia’s railroad industry consisted in the demand for powerful high-capacity locomotives to service the growing freight turnover. The world war boosted this demand. Four-axle locomotives of “O\textsuperscript{m}” series failed to meet the challenge. Their limited axle load caused designers to develop a five-axle locomotive discussed in this work. However the manufacturing of such machines was feasible due to the poor condition of railroads in Russia before the war, as the locomotive that had five power-driven axles mounted to a rigid frame had problems passing turns and points. That’s how an intermediate “SCH” series appeared.

Any advancements in the design and manufacturing of locomotives were driven by the needs of the military. The growing demand for freight railroad vehicles was boosted by the Russian-Japanese war. Because of the war, thee country needed higher capacity locomotives than those in operation back then. State-owned railroad authorities replaced worn out lightweight rails by heavier ones. Three-axle
locomotives, primarily supplied in the 50ies and 60ies of the 19th century, were done away with (0-3-0). The process of designing a new series of locomotives was initiated by professor N.L. Schukin following the order issued by K.S. Nemeshev, Minister of railroads. Schukin did not limit his project to the 0-5-0 axle, which had been widely used by West European designers, as he believed that Russian railroads were incompatible with five-axle locomotives. He assumed that the 0-4-1 design was best for a locomotive to be used by the East-Chinese and Vladikavkaz railroad authorities.

Predecessors of his steam locomotive were entitled “modified type 1-4-0 locomotives designated for the East Chinese railroad authority” or “the normal type designed in 1905.” Locomotives of the “SCH” series were produced by the factories that belonged to the Russian Locomotive Building Society, and in 1911 their production was initiated by the Nikolaev shipyard. The cars, driven by the steam locomotives of this series, could develop the speed of 16 km/hour. One steam locomotive could have forty-three freight cars with 12 tons of payload each.

Therefore, the axle design, developed by N.L. Schukin, was based on the 1-4-0 formula; that means that his model had four pair of power-driven wheels and one pair of pilot wheels. Their manufacturing did not take a long time; therefore, their share in the fleet of locomotives in the days of WWI was substantial: there were 2,000 locomotives of this series in operation. A pair of pilot wheels made these locomotive swifter, and steam engines made them more efficient. However, this feature added no significant strengths when a locomotive was in operation.

![Figure 2](image-url)

**Figure 2.** The number of “E”, “O” and “SCH” series steam locomotives built

And now let’s answer the question whether the above number of locomotives was sufficient. In 11914, the average number of steam locomotives per 100 km of railroads in other countries reached 64 in the UK, 54 in Belgium, 47 in Germany, 35 in Italy and 33 in France. These values can be compared with those in Russia, where the number of locomotives did not exceed 30 per 100 kilometers of railroads. On the eve of WWI, the number of locomotives went down in Russia. These qualitative characteristics have proven the gap between Europe and Russia. However, in the USA this number was half as much, although North-American railroads, which were separated from the scene of military operations by the ocean, were used for completely different purposes.

The production of steam locomotives in Russia did not stop in the years of WWI: in 1914, 763 locomotives were manufactured; in 1916, their number went down to 600; in the year of 1917, 420 items were made. However, the number of locomotives produced back in 1913, was 609, and it plummeted to 214 in 1918. In the days of the civil war and military communism the production of steam locomotives kept shrinking, and later, in the days of industrial renaissance, the locomotive industry could not match the pre-war figures for quite a long time. Indeed, in the 20ies of the 20th century, the production of locomotives stopped in the context of the post-war disorder and military
The locomotives, manufactured before WWI were still in operation, and this fact proves their high safety margin. The production of locomotives in 1912 – 1922 is illustrated in figure 3. The author has no intention to analyze the production of locomotives in the USSR. However it is noteworthy that, unlike the locomotive production pattern in the days of WWI, the number of locomotives produced in the days of WWII plummeted: the country took advantage of the fleet produced before the revolution and in the course of the first five-year plans. The figures were striking: in 1941, 708 locomotives were made; in 1942, their number went down to 9; in 1943, the country produced 43 locomotives; in 1944, Russia made 32 locomotives, and in 1945, mere 8 locomotives were produced (see figure 4).

4.4. Production of locomotives in the early 20th century
Let’s analyze the fleet of railroad cars art the disposal of our country in the days of WWI. In 1914, the application, filed by the Ministry of Railroads, requesting the production of 16,700 railroad cars, was not satisfied by the State Duma in full, as only one half was produced. This move made an immediate adverse impact on the delivery of supplies designated for the front and the rear areas. For example, of 73 production facilities that remained idle in December, 1916, 39 remained idle due to the unavailability of any fuel. Although both fuel and food were available at substantial distances, they were impossible to deliver, as each means of transport delivered military cargoes as a top priority, and no locomotives were there to reach the rear areas. The country avoided the disruption of transportation thanks to sensible solutions made by the railroad authorities. They established a strategic reserve of
freight cars, based on the potential needs of the army. The information about the availability of freight cars was submitted by the Ministry of Railroads to military authorities.

However no sensible solutions could compensate for the insufficient inflow of supplies needed for railroads and railroad troops. The insufficiency influenced the transportation logistics during WWI.

Thanks to several technological solutions, railroad cars could be used to transport both nonmilitary and military cargoes. Freight cars were easily convertible into 4th-class passenger cars: windows were made, fans and toilets were installed to convert a freight car into a passenger one, and holes were made in ceilings for candle lamps. Passenger benches and luggage shelves were installed inside the car. Some passenger cars were converted into hospitals. As it was mentioned, railroad cars can be used for military and nonmilitary purposes, and this ability is a feature of railroads as the means of transport [16]. Fifty years after the end of WWI, when novel and more destructive nuclear weapons entered operational service, freight cars were also used for military purposes. Here is a contemporary example of the dual use of railroads: a railway car-based ICBM (intercontinental ballistic missile) was initially a refrigerator car designated for perishable food products. These cars are in operational service now. To convert a car into an ICBM, an engineer must have its wheels and axles replaced.

The emergence of a “regular” railroad car boosted the freight turnover. The construction of a “regular” freight car was used as a benchmark for other freight cars which were adjusted to meet regular specifications. The majority of freight cars had frames, springs, wheels and axles typical for a “regular” car. In the late 19th – early 20th centuries, the Ministry of Railroads changed the capacity of cars: in 1891 it was boosted to 12.5 tons, in 1909 – to 15 tons, and in 1911 – to 16.5 ton (or 1,000 pooods).

Russian freight cars had so-called “broad specialization” due to the heterogeneity of cargoes, diversity of transportation environments and extensive territories. Therefore, “regular” cars were used as the basis for different constructions and platforms (including those designated for the transportation of timber), open railroad freight cars (designated for firewood, coal and other cargoes), as well as mail, hospital, convict, cattle, ice, alcohol, fruit and tank cars.

In the late 20th -early 21st century, railroad authorities focused their efforts on gaining independence from foreign supplies. This independence became salvation in the days of WWI. Construction materials, railroad cars and new production facilities were produced or somehow organized in Russia. For example, a township-forming production enterprise, based in Mytisch, had both military and nonmilitary contracts. Back in 1897, Moscow joint stock company of railroad car building launched its operations on the banks of the Yauza river. It founded an industrial community that was later converted into the Moscow satellite town. Its shareholders included S.I. Mamontov, holder of the hereditary title of the citizen of honour, A.V. Barry, an engineer, a US citizen (V.G. Shukhov, an engineer, worked for his production facilities) and K.D. Artsybushev, a nobleman.

5. Conclusions
To sum up our research, we can make a conclusion that in the early 20th century railroad transport served as the driver that boosted the development of new types of weapons. Numerous types of arms were installed into railroad cars. New types of weapons and military cargo delivery schedules were developed with due regard for the load carrying capacity and dimensions of “regular” freight cars. Weight standards were applied to freight cars for the latter to be able to travel all over the railroad network in case of military operations and in any other circumstances.

European empires pursued military objectives by launching railroad networks. Transregional railroads were built to solve problems of military logistics. In Europe these railroads connected Berlin and Baghdad; in Russia the Trans-Siberian railroad was built, as well as other lines that connected agricultural and industrial areas and the borders of the Empire. Railroads penetrated into the centre of the country and promoted the launch of industrial enterprises there by getting vast areas involved in profit generation. The Trans-Siberian railroad line was an ambitious undertaking that connected Vladivostok and Moscow. Its construction took mere ten years. A contemporary economist says: “The
area of immediate economic influence of the Trans-Siberian railroad line reached 200 versts by overland transport and 700 – 800 versts by water" [17].

One should not insist that the military needs completely suppressed the private initiative in terms of railroad transportation, although some historians think this way. In the early 20th century, the railroad transport triggered the development of the Russian military and nonmilitary industries in many Russian provinces. During this short period of prosperity, numerous railroad operators acquired side businesses and developed them even in the days of the war. Indeed, the Joint Stock Company of the Ryazan-Ural railroad incorporated a steamboat operator: cargo ships and travel boats traveled along the Ural river. The Saratov fleet owed by the Ryazan-Ural railroad delivered cargoes over the Volga river. A railroad operator located in a different Russian region, or the Joint Stock company of the Armavir-Tuapse railroad, was authorized in the days of WWI to exploit coal mines, oil wells, buy country houses in the forests. Experimental orchards and vegetable gardens were planted following the decision made by the company executives. There, grain sorts were improved and cattle was ranched. Railroads stepped in to develop nearby territories, including those occupied by small and mid-size settlements. It’s one of the features typical for the rear economy during WWI.

Grain storage barns were built at major railroad stations to facilitate grain transportation to the front and to rear areas. By 1913, huge power-driven elevators had been built in Moscow, Kolomna, Zaraisk, Ryazan. Special barns were built in Penza, Tambov and Simbirsk governorates not far from railroad stations. In 1913, a mechanically cooled warehouse was built for long-term storage purposes.

On top of an enterprise, that satisfied the needs of railroads, Mamontov, acting together with other Russian entrepreneurs, launched an iron foundry in Nizhneudinsk, an ore mining enterprise in Alapayevsk, a mechanical factory in St.Petersburg and a number of timber processing plants.

The author analyzed the principal milestones in the development of a network of railroad routes in the context of WWI in this work. The experience, accumulated by railroad workers, locksmiths, railroad engineers, designers of locomotives and freight cars, entrepreneurs, who made investments into military and other projects in emergency situations, is particularly important today, as numerous production industries and transport operators have to function amid the pandemic. The qualification of their personnel and their ability to act positively and consistently are a key to the successful development of the transport industry. In this sense, assimilation of dual technologies was of particular importance, as they facilitated the transportation of military and nonmilitary cargoes.

Now that over a hundred years have passed since WWI, we need to learn its lessons. Railroad workers also have lessons to learn. The railroad industry perceived crises as challenges to its development, while any development of the transportation system produced a positive impact on regional economies [18] [19]. The history of transport is particularly relevant at the current stage of economic development (its historical background is analyzed in [20] [21].

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