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Normative bases of labor costs influence on construction duration and crew forming

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ABSTRACT

The paper considers the scheduling of construction of four objects using three different normative bases: Unified Norms and Prices (further – UN&P, Russia), KI “Rakennustöiden laatu RTL” (further – RATU, Finland), “Building Construction Costs with RSMeans Data” (further – RSMeans, United States of America, USA). An integrated approach to the calculation of amounts of works for each object, labour hours, the number of labours in the construction crew, allowed to reveal fundamental differences in terms of the building and its resource providing. The conducted research gives an opportunity to objectively assess the applicability of certain standards in today's construction market. According to the results of researches it was found that the smallest duration of construction is achieved by applying a normative base RSMeans (USA). The maximum duration of construction is obtained with the use of a domestic normative base. These conclusions indicate the necessity of modernization of the national normative base in building and possible integration of foreign one for the most effective scheduling of construction within the set terms and with necessary level of quality.

Content

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1. Introduction

Nowadays, construction going on with delays due to incorrect drafting risks. It gives a serious reduction of construction development. The reason for the time limits delay can be a lot of factors. Appropriate crew formation and obligatory work schedules stimulate the timely date of substantial completion.

Relevant examples can be large construction projects or building construction as a whole. Often, construction is “frozen” due to the contractor bankruptcy or due to the fact that work deadlines were not met. Usually after that should be chosen a new contractor and drafted a contract with him to complete the work. This process can take several years.

The scheduling purpose in construction – complete works on time and with the required quality. Construction terms optimization had always been one of the main tasks of scheduling, which were solved and are solving by many contemporary researchers [1–6]. Today, the delay of construction terms is the most important problem, which requiring to be solved in modern automated construction process. Such factors as an insufficiently objective assessment of construction risks, an employment of unskilled construction crews, a lack of financing, an inaccuracy of work duration calculations can increase the number of untimely object finishing.

The monograph [7] noted that any investment-construction projects in the present conditions are evaluated by three factors: cost, timeliness, quality. All these factors are interrelated with each other. In the source [8], the author addresses to the issue of the assessment of construction workers qualification rating. This topic is very relevant, because timeliness and quality directly depend on construction workers qualification. As a worker was chosen steel erector, who got 2nd level of qualification. He was estimated by two criteria. The evaluation result is a diagram, which shows to employer ratio of workers qualification by different criteria and gives appropriate coefficient for further evaluating and analyzing workers qualification level according to the established norms. It leads to development of construction process. Based on an analysis in this paper, it is necessary to solve the following purpose and objectives. In the work [9], the author analyses the foreign development experience and applies foreign construction normative base of labor costs. The lack of present-day construction normative bases of labor costs and existing price formation system prevents the use of high-efficiency technologies, leads to construction cost exponentially increases and, of course, later will rise up cost of building maintenance. Costs have an extremely high level in some cities and regions.

The most famous object, whose construction is not completed in planned time in St. Petersburg, is: “Zenit-Arena”. This object is the main city “unfinished”. The object located on Krestovsky Island. Building of stadium had started on the Kirov Stadium construction site in 2008. Initially the construction cost was estimated at 13 billion rubles. After the state project examination, which took place in 2008, the construction was estimated at 23.7 billion rubles. After bringing the stadium into FIFA standards requirements in 2013, the cost of construction has risen up to 34.9 billion rubales. Legislative Assembly approved the allocation of another 4.3 billion rubles due to inflation in the spring of 2016. According to contract conditions the company is obliged to complete the construction before the end of 2016. In this way, any minimal construction duration increases and can lead to a significant growth of investor expenses or to the construction company bankruptcy [16, 17].

Currently, the single object construction can be carried out by companies from different countries, for example, the shopping centre “Ohta-Mole” (Finland and Russia) or residential complex “Duderhof Club” (China and Russia). Companies during the construction projects scheduling use normative base of labor costs in accordance with applicable nationwide directories. However, joint projects implementations establish the issue of objective and appropriateness integration of any given foreign normative base of labor costs in individual case of construction procedure.

The aim of this work is construction work scheduling of four typical objects - houses, using three different normative bases of labor costs: Unified Norms and Prices – UN&P (Russia), “Rakennustöiden laatu RTL” – RATU (Finland), “Building Construction Costs with RSMeans Data” – RSMeans (USA). This will give an objective assessment of possible using one or other standards in present-day construction market and probably optimize duration of constriction.

To achieve the aims, it is necessary to solve the following tasks:

1. To calculate the volume of work for four construction objects
2. To work out schedules by three normative bases of labor costs: UN&P, RATU, RSMeans.
3. To analyze the building crew formations and qualification level, selected in accordance with the normative bases of labor costs.

UN&P is a big summary of documents regulating unified norms and prices for construction, installation and repair work, installation of precast and monolithic reinforced concrete structures. This database was last updated

on 18th of December, 1990(9). Normative base Ratu is collection of labor cost and cost of materials. For updating data in Ratu publication responsible fund “Stroyindustria RT” and fund “Stroyinfo RTS”. In the process of data collection annually involves a huge amount of construction companies and construction sites, and, by this way, new data of labor costs and the costs of materials are constantly emerging, moreover, updates labor costs and cost of materials which were studied in past. The present publication of Ratu contains data of labor costs and costs of materials in relation to new construction and reconstruction [10]. Normative base RSMeans – the world’s leading provider of construction cost data, software, and services for all phases of the construction lifecycle. RSMeans data from Gordian provides accurate and up-to-date cost information to help owners, developers, architects, engineers, contractors and others carefully and precisely project and control the cost of both new building construction and renovation projects [11].

2. Methods and Results

In this paper the objects of research are four typical cottages, symbols as objects a, b, c and d. Floor plans of objects are shown in figure 1:

Figure 1.1. Plan of building A

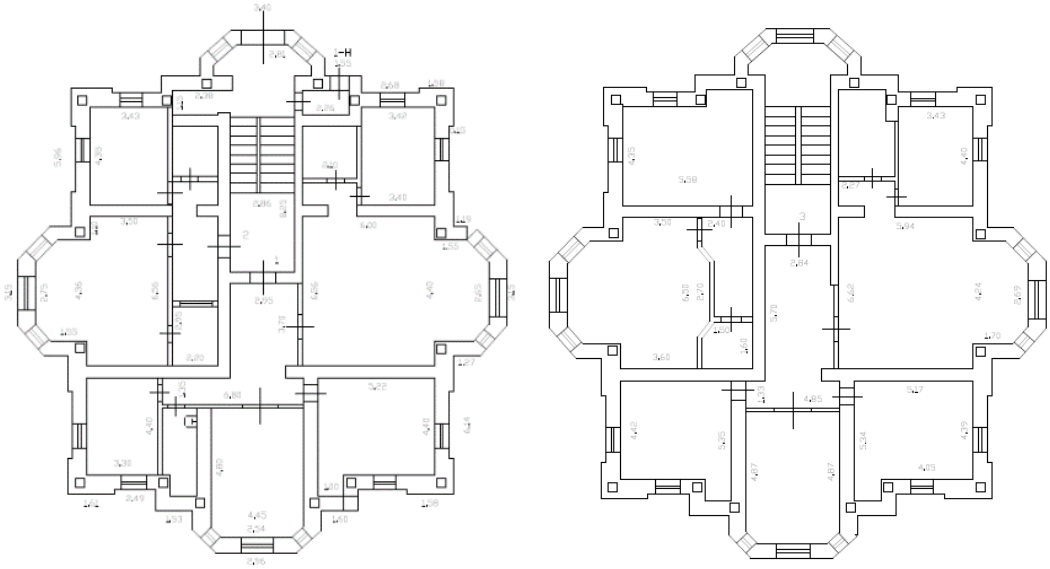

Figure 1.2. Plan of building B

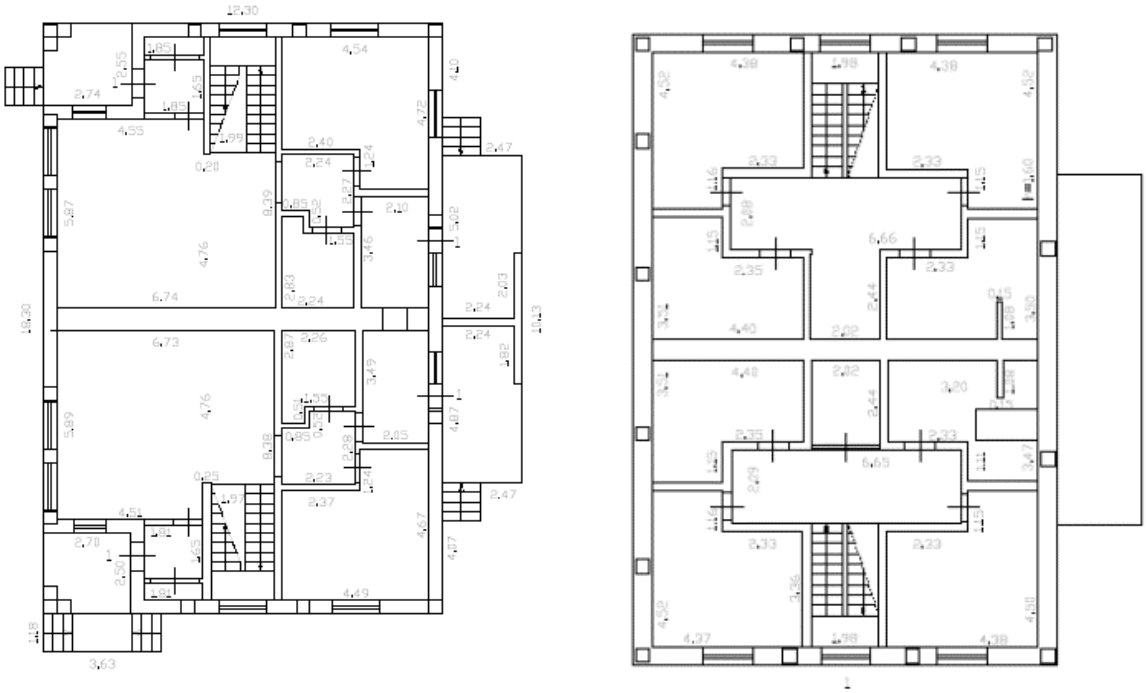

Figure 1.3 Plan of building C

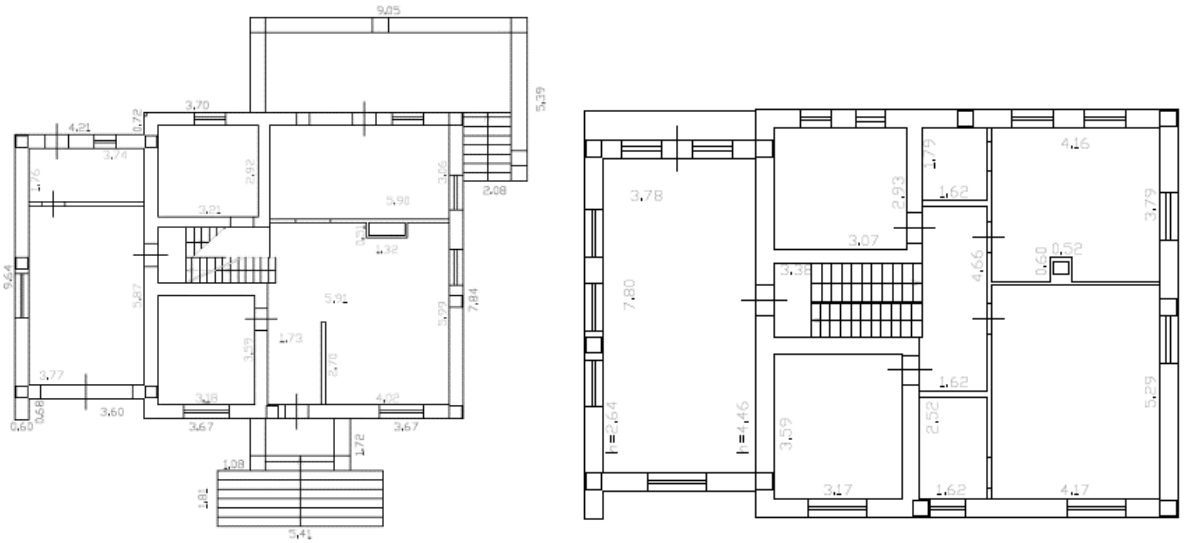

Figure 1.4 Plan of building D

Figure 1. Plan of building A Special arrangement of a buildings A,B,C and D

Table 1 shows the calculated volume of construction work for each objects a, b, c, d, and the value of work labour input, calculated with the use normative bases of labour costs: UN&P, Ratu, RSMeans.

Table 1. Volume of work and work labour input for building sites A, B, C and D.

Number of work	Object	Type of work	Volume of work	Work labour input		
				UN&P	RATU	RSMeans
1	a	Installation of concrete slabs(walls)	184.30m^3	31.79	20.04	0.49
	b		153.12 m^3	26.40	16.65	0.41
	c		118.08 m^3	20.36	12.84	0.38
	d		72.08 m^3	12.43	7.84	0.19
2	a	Installation reinforcing bars in columns	0.89 tn	1.34	1.09	0.66
	b		0.84 tn	1.26	1.03	0.62
	c		0.73 tn	1.10	0.90	0.54
	d		0.52 tn	0.79	0.64	0.38
3	a	Colums formwork install ation	299.20 m^3	12.34	33.66	12.46
	b		281.60 m^3	11.61	31.68	11.73
	c		246.40 m^3	10.16	27.72	10.26
	d		176.00 m^3	7.26	19.80	7.33
4	a	Concrete placing in columns by plump	14.96 m^3	2.80	0.72	0.32
	b		14.08 m^3	2.64	0.68	0.30
	c		12.32 m^3	2.31	0.60	0.26
	d		8.80 m^3	1.65	0.42	0.19
5	a	Removing the formwork	299.20 m^3	5.98	10.09	12.46
	b		281.60 m^3	5.63	9.05	11.73
	c		246.40 m^3	4.92	8.31	10.26
	d		176.00 m^3	3.52	5.94	7.33
6	a	Facing bricklaying (2 layers)	73.80 m^3	68.26	7.56	1.62
	b		69.72 m^3	64.49	7.14	1.53
	c		67.65 m^3	62.58	6.93	1.48
	d		41.98 m^3	38.83	4.30	0.92
7	a	Installation of concrete slabs(sub walls)	145.70 m^3	18.21	4.55	1.01
	b		78.63 m^3	9.82	2.45	0.54
	c		65.76 m^3	8.22	2.05	0.45
	d		33.56 m^3	4.19	1.04	0.23
8	a	Installation of concrete stair	1.00 m^3	0.34	0.16	0.01
	b		1.00 m^3	0.34	0.16	0.01
	c		2.00 m^3	0.68	0.33	0.02
	d		1.00 m^3	0.34	0.16	0.01

Using the table 1, then work labour input values are known, the duration of each construction and assembly work could be able to calculate, as well as the total number of days required for the construction of objects a-d.

Obtained values are presented in the table 2 and graphically in figure 1.

Table 2. Duration of works in days

Object	Normative base	Time of work, day								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	Total
a	UN&P	6	2	6	6	4	4	4	1	43
	RATU	5	1	6	6	5	5	4	1	33
	RSMeans	2	2	2	6	2	2	2	1	19
b	UN&P	6	2	6	6	4	2	2	1	39
	RATU	4	2	6	6	6	4	2	1	31
	RSMeans	2	2	2	6	2	2	2	1	19
c	UN&P	6	2	6	6	4	2	2	1	39
	RATU	4	2	6	6	6	4	2	1	31
	RSMeans	2	2	2	6	2	2	2	1	19
d	UN&P	4	2	4	6	1	8	1	1	27
	RATU	2	2	4	6	4	4	1	1	23
	RSMeans	2	2	2	6	2	2	2	1	19

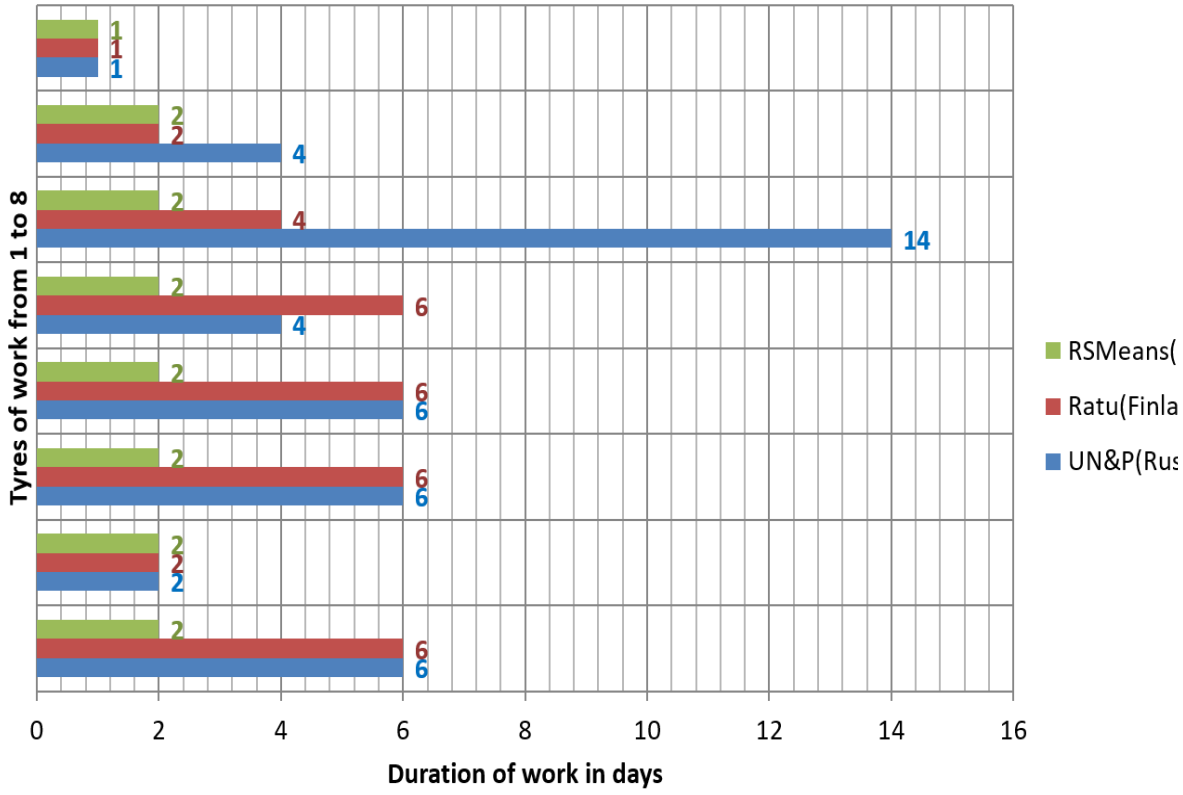

Figure 2. Quantitative comparison of work duration (object a)

Figures 3, 4, 5 show an example of a schedule for an object a constructed using three normative bases.

1	**1st floor**	**30 days**
2	**slabs**	**3 days**
3	Installation of concrete slabs(walls)	3 days
4	**walls**	**27 days**
5	Installation reinforcing bars in columns	1 day
6	Colums formwork installation	3 days
7	Concrete placing in columns by plump	1 day
8	Removing the formwork	2 days
9	Facing bricklaying(2 layers)	17 days
10	Installation of concrete slabs(sub walls)	2 days
11	Installation of concrete stair	1 day
12	**2 floor**	**29 days**
13	**slabs**	**3 days**
14	Installation of concrete slabs(walls)	3 days
15	**walls**	**26 days**
16	Installation reinforcing bars in columns	1 day
17	Colums formwork installation	3 days
18	Concrete placing in columns by plump	1 day
19	Removing the formwork	2 days
20	Facing bricklaying(2 layers)	17 days
21	Installation of concrete slabs(sub walls)	2 days

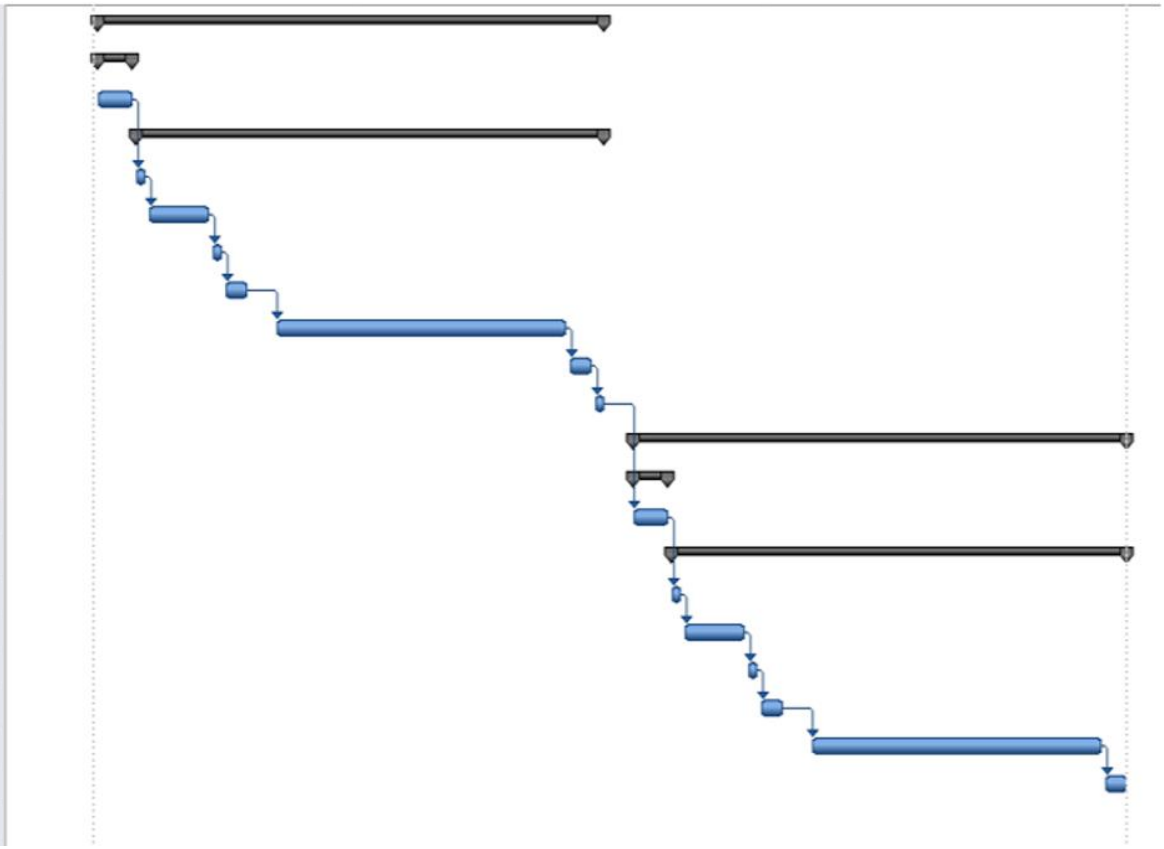

Figure 3. Schedule for UN&P (Russia) system

Total duration of construction is 59 days.

1	1st floor	20 days
2	slabs	1 day
3	Installation of concrete slabs(walls)	3 days
4	walls	17 days
5	Installation reinforcing bars in columns	1 day
6	Colums formwork installation	8 days
7	Concrete placing in columns by plump	1 day
8	Removing the formwork	3 days
9	Facing bricklaying(2 layers)	2 days
10	Installation of concrete slabs(sub walls)	1 day
11	Installation of concrete stair	1 day
12	2 floor	19 days
13	slabs	3 days
14	Installation of concrete slabs(walls)	3 days
15	walls	16 days
16	Installation reinforcing bars in columns	1 day
17	Colums formwork installation	8 days
18	Concrete placing in columns by plump	1 days
19	Removing the formwork	3 days
20	Facing bricklaying(2 layers)	2 days
21	Installation of concrete slabs(sub walls)	1 day

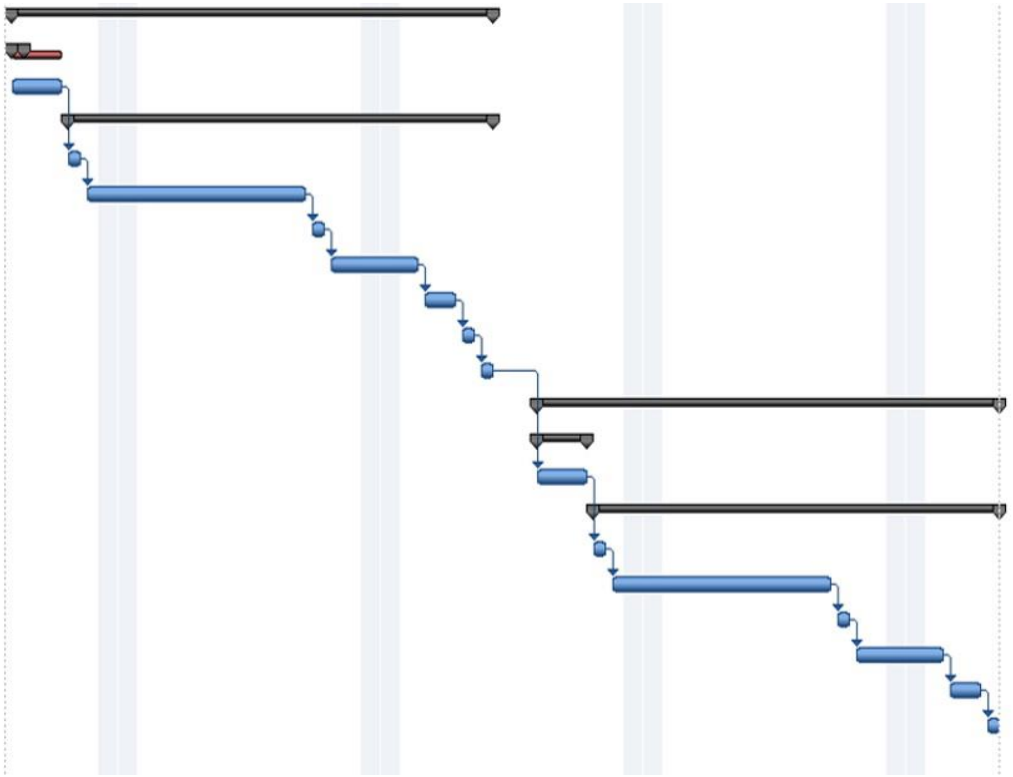

Figure 4. Schedule for Ratu system

Total duration of construction is 39 days.

1	**1st floor**	**8 days**
2	**slabs**	**1 day**
3	Installation of concrete slabs(walls)	1 day
4	**walls**	**7 days**
5	Installation reinforcing bars in columns	1 day
6	Colums formwork installation	1 day
7	Concrete placing in columns by plump	1 day
8	Removing the formwork	1 day
9	Facing bricklaying(2 layers)	1 day
10	Installation of concrete slabs(sub walls)	1 day
11	Installation of concrete stair	1 day
12	**2 floor**	**7 days**
13	**slabs**	**1 days**
14	Installation of concrete slabs(walls)	1 day
15	**walls**	**6 days**
16	Installation reinforcing bars in columns	1 day
17	Colums formwork installation	1 day
18	Concrete placing in columns by plump	1 day
19	Removing the formwork	1 day
20	Facing bricklaying(2 layers)	1 day
21	Installation of concrete slabs(sub walls)	1 day

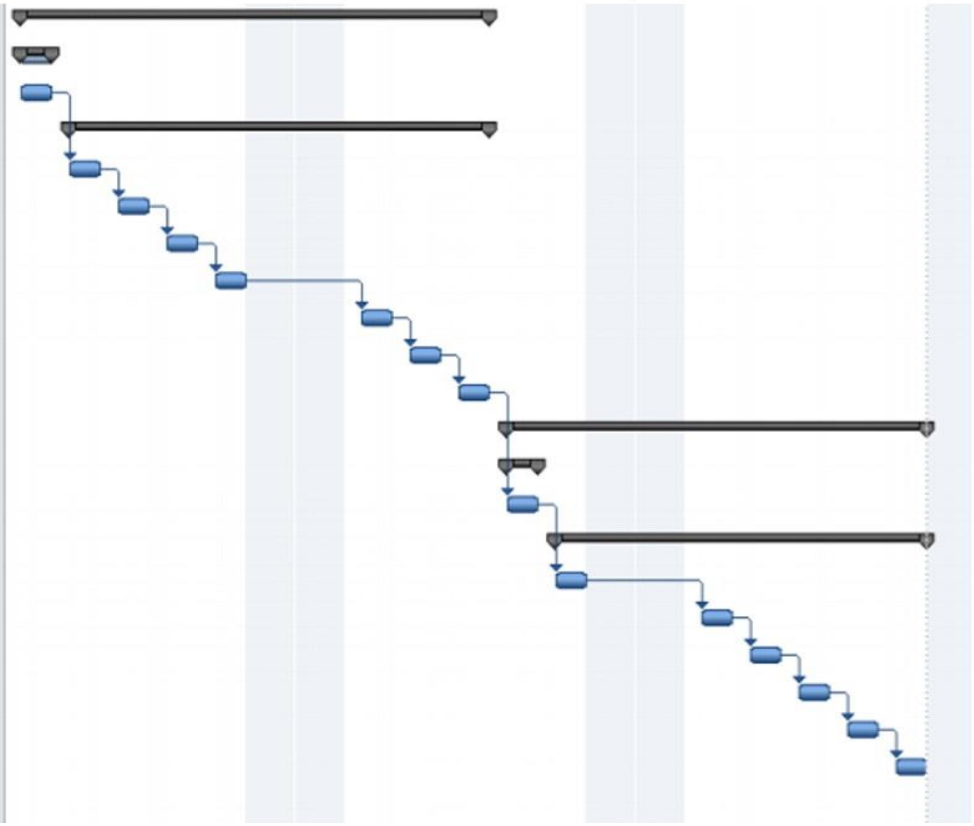

Figure 5. Schedule for RSMeans system

Total duration of construction is 15 days.

For the objects a, b, c, d construction crews have been formed. Data on labor hours, professions and the number of labors in a crew have been taken from the normative bases.

Romanovich M., Musorina T.A., Starshinova E.D., Sushkov N.N. Normative bases of labor costs influence on construction duration and crew forming / Романович М., Мусорина Т.А., Старшинова Е.Д., Сушков Н.Н. Влияния нормативных баз разных стран на продолжительность строительства и формирование бригад ©

Table 3 shows an example of comparison of two construction crews formed with the normative bases UN&P and RSMeans.

Table 3. Comparison of construction crews

№	Type of work	Normative base			
		UN&P	Number of labors	RSMeans	Number of labors
1	Installation of concrete slabs(walls)	Steel erectors:			
		5 category	1	Structure steel foreman	1
		4 category	1	Structure steel workers	6
		3 category	1	Equipment operator (crane)	1
		2 category	1	Equipment operator (oiler)	1
		Crane operator			
		6 category	1		
2	Installation of reinforcing bars in columns	Steelfixers:		Rodman(steelfixer)	4
		5 category	1		
		2 category	1		
3	Colums formwork installation	Mechanics			
		4 category	1	Carpenters Foreman (outside)	1
		3 category	1	Carpenters	4
				Laborer	1
4	Concrete placing in columns by plump	Concrete workers:		Labor Foreman (outside)	1
		4 category	1	Laborers	5
		2 category	1	Cement Finisher	1
				Equipment operator (medium)	1
5	Removing the formwork	Mechanics			
		4 category	1	Carpenters Foreman (outside)	1
		3 category	1	Carpenters	4
				Laborer	1
6	Facing bricklaying	Bricklayers:		Bricklayers	3
		3 category	2	Bricklayer Helpers	2
7	Installation of concrete slabs (sub walls)	Steel erectors:		Carpenter Foreman (outside)	1
		5 category	1	Carpenters	5
		4 category	1	Laborers	4
		3 category	1	Rodmen	4
		2 category	1	Cement Finishers	2
		Crane operator		Equipment operator (crane)	1
		6 category	1	Equipment operator (oiler)	1
8	Installation of concrete stair	Steel erectors:		Carpenter Foreman (outside)	1
		5 category	1	Carpenters	3
		4 category	1	Laborer	1
		3 category	1	Equipment operator (crane)	1
		2 category	1		
		Crane operator			
		6 category	1		

Figure 6 shows the fundamental difference in the number of labors in construction crews, formed using different normative bases.

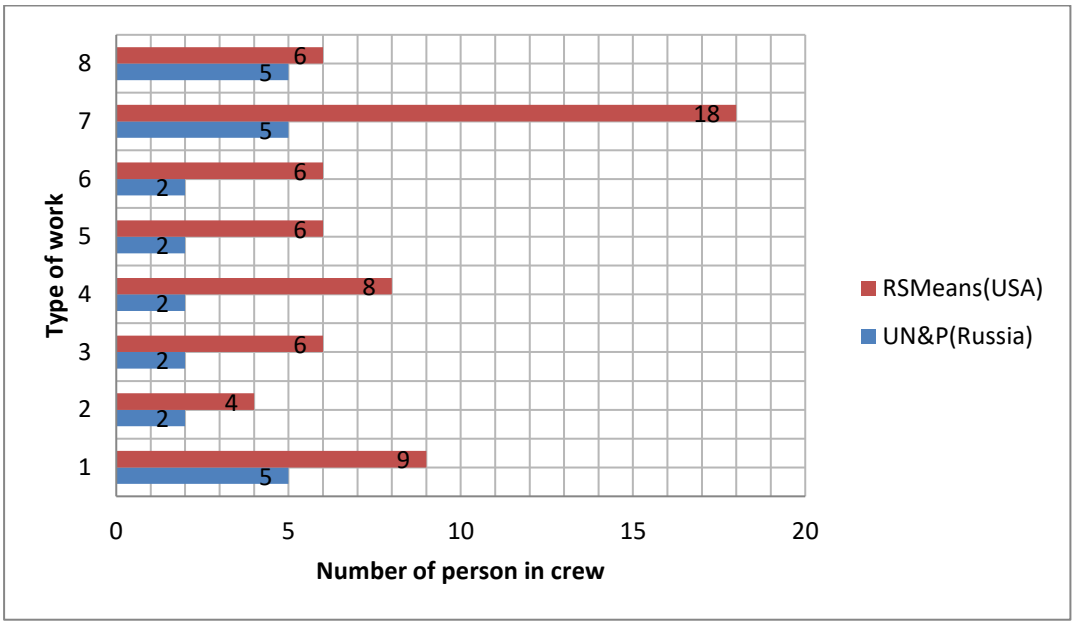

Figure 6 Quantitative comparison of construction crews

3. Discussion

Calculations, which were obtained in this paper, give the base to the conclusion, that Russian construction normative base of labor costs is outdated. It was updated in the early 90s of the last century. In this regard, there is a difference in the time length of construction, almost two times bigger for each of the projects. Therefore, construction standards in Russia need updated or there are needs of new requirements creation. Modern American normative base of labor costs RSMeans gives the most targeted results in calculations, no matter there are big or small construction work volume in project. But the modern system does not take into account the level of construction worker qualification. It takes into account the number of members, but not the level of them. Consequently, this issue is also a problem.

In the system UN&P construction worker qualification takes into account, but “the workers question” can also create problems. As high the level of worker qualification, as high he will be paid, so the total price of construction will grow up. This is the answer to the question why there are a lot of inappropriate quality of completed project and unfinished constructions.

Based on the literature review, this paper is unique by reason of the fact, that previous authors did not compare and had not estimation results according to three absolutely different normative bases of labor costs.

4. Conclusions

According to the tasks that have been given in this paper, the conclusions follow:

1) The 4 two-storied residential cottages were used, which were calculated from 3 international normative bases of labor costs. With them it was able to compare the 8 types of work on the Russian, American, Finnish base.

2) Crews comparative analysis showed that in case of using modern normative bases of labor costs RSMeans formation construction crews going well. The rate of construction increased by rising the numbers of workers on the construction site.

3) To compare the duration of the construction, two-storied residential cottages schedules have been analyzed. In two cases, it is clear that if you do the calculation with normative bases of labor costs RSMeans, the necessary number of days for the construction is halved, in comparison with UN&P.

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Влияния нормативных баз разных стран на продолжительность строительства и формирование бригад

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КЛЮЧЕВЫЕ СЛОВА

здания;
строительство;
гражданское строительство;
продолжительность строительства;
планирование;
основы нормативных затрат на оплату труда;
трудозатраты работ;
строительная бригада;

АННОТАЦИЯ

В работе рассмотрено календарное планирование строительства четырех объектов с использованием трех различных нормативных баз: Единые нормы и расценки на строительстве – ЕНиР (Россия), KI “Качество строительства RTL" – РАТУ (Финляндия), Затраты на строительство с использованием данных RSMeans – RSMeans (Соединенные Штаты Америки – США). Комплексный подход к расчету объемов работ по каждому объекту, трудоемкостей, количества людей в бригаде, позволил выявить принципиальные различия в сроках строительства и его ресурсном обеспечении. Проведенное исследование дает возможность объективно оценивать применимость тех или иных стандартов на современном строительном рынке. По итогам проведенных в работе исследований было выявлено, что наименьшая продолжительность строительства достигается путем применения нормативной базы RSMeans (США). Наибольшая продолжительность строительства получается при использовании отечественной нормативной базы ЕНиР, практически в два раза дольше. Данные выводы свидетельствуют о необходимости модернизации отечественных нормативных баз в строительстве и возможной интеграции зарубежных для максимально эффективного календарного планирования строительства объектов в заданные сроки и с необходимым уровнем качества.

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