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COMPARATIVE ANALYSIS OF TWO TYPES OF PRODUCTION OF X-RAY TOMOGRAPHIC SCANNERS

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X-ray technique was developed in 1895 and immediately found application in medicine. It is designed for non-invasive diagnosis of the internal structure of the body (blood vessels, bones, soft tissue, brain) by means of X-rays. Investigation by X-ray is the most common method of diagnostics in medicine, and is used in critical diagnostic processes as X-rays, CT scan, biopsy, etc. At present, virtually no patient record does without X-ray equipment.

According to the data of Discovery Research Group, the Russian market for medical products in 2011 amounted to 120 billion rubles, which is 20 % higher than in 2010. The volume of production of medical equipment in 2011 totaled about 27.5 billion rubles, which is 21.4% higher than in 2010. Thus, the average growth in the market of medical equipment in Russia is 10-12 %. Diagnostic equipment market in 2011 was 43% of the market of medical equipment and medical supplies. Market of equipment for radiation diagnosis was 62% of the market of diagnostic equipment and, consequently, 27 % market share of all medical equipment. Its volume in 2011 was 31.6 billion rubles, which is 30 % higher than in 2010 [4]. X-ray equipment is 52 % of the market beam diagnostic equipment market and 14 % of all medical equipment. The share of CT scanner's market is 18 % and 3 % of the entire market of medical equipment accounting for 3 billion rubles a year.

The most relevant, innovative and useful product among the large range of x-ray diagnostic products is a computer X-ray tomographic scanner. The first mathematical algorithms for CT were developed in 1917 by J. Radon, and the first device was implemented in 1972 by

G.Haunsfild and A.Cormac in the UK - it was a brain scanner produced by the British company EMI. Since then, CT has undergone significant changes, has been upgraded, found new useful applications in medicine and moved to a new stage of development. Currently, imaging continues to evolve and is currently the fastest growing area of X-ray equipment and medical equipment in general. Since the early 1980s the fifth generation CT scanners has been under development. The latest development is a computer X-160-slice CT scanner Aquilion PRIME, which was introduced by Toshiba Medical Systems Corporation in January 2011 [5].

However, the scanner is one of the most sophisticated and expensive products in the entire market of medical equipment. According to experts, domestic manufacturers account for only 16% to 20% of the total market of medical equipment. The market share of high-tech equipment of domestic production is half as large as the foreign market. The first Russian medical X-ray CT-scanner SRT-1000 was developed in 1978 under the guidance of I.Rubashov, who headed CT Institute in 1987-1998. But it didn't prove to be commercially successful and currently there is no X-ray tomography of domestic manufacture in Russia. At the moment in Russia there are only a few companies who have their own development department and production facilities for scanners production in Russia.

The price of a CT-scanner which was brought from abroad greatly exceeds the cost of a CT-scanner produced in Russia. Therefore it's necessary to improve domestic production. There are two possible ways: the first way is to produce proprietary scanners, the second - to make a third-party scanners, that is to promote overseas development. We have analyzed the life cycle of the imager based on the life cycle curve to determine which of these two paths will be the most promising and profitable one for the manufacturer. Having analyzed and defined the required parameters of the production cycle and knowing the sales plan, you can fully describe the whole life cycle characteristic and a curve of the life cycle for each case, and then to compare these curves and draw conclusions about the most promising type of production.

The production cycle can be divided into several stages: first one is R & D, the second - preparation for mass production, and the third - production. The first phase includes research and development work, i.e. a set of activities aimed at obtaining new knowledge and its practical application in the creation of a new product or technology. The second phase includes all processes associated with the preparation of the production base for mass production: equipment, training, etc. The third stage is production itself [2].

For the analysis we chose the classic type of sales plan, which consists of several stages: the stage of market introduction, growth stage, the stage of maturity, the stage of fall. Stage launching into the market is characterized by slow growth of sales and minimal profits, until the product is pushed through the channels of distribution. Successful product enters into the growth

stage, which is characterized by rapid growth in sales. At this stage, the company aims to improve the product to penetrate into new market segments and distribution channels, as well as slightly lower prices. This is followed by the stage of maturity in which sales growth slows down and profits stabilize. Finally, the product enters the stage of decline, when sales and profits are reduced [1].

Only 32-slice CTs are produced and sold in Russia at the moment, and the next step should be the production of a 64-slice CTs. Given the dynamics of the CT-scanner's market growth, the relevance of 64-slice CT sales will continue until about 2023. Accordingly, the sales plan should cover the next 10 years.

For the analysis we use the data obtained by Orion Company. Tables 1 and 2 show all the necessary data to analyze for first type of production.

Table 1

Parameters of the first and second stages of the production cycle in for in-house X-ray tomographers' design

R&D		Pre-production		total	
Duration (year)	Costs (mln.rubles)	Duration (year)	Costs (mln.rubles)	Total time before sales (year)	Total costs (mln.rubles)
4,0	200,0	2,0	100,0	6,0	300,0

Table 2

Parameters of the third and fourth stages of the production cycle for in-house X-ray tomographers' design

ye ar	les tar	Manufacture	Sales	ofi t (m

		Number of workers	Average salary of worker (rub)	area (м2)	price for 1 square meter (rub)	Equipment exploitation cost (rub)	Cost of components (mln.rub)	Total cost of production (mln.rub)	Market price (mln.rub)	Profit (mln.rub)	Clear profit (mln.rub)	
0	0,0	0	0,0	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-300,0
1	10,0	120	35000,0	2000	4200,0	1800,0	8,0	92,6	25,0	250,0	157,4	-142,6
2	35,0	120	37800,0	2000	4240,0	1830,0	7,9	289,5	30,0	1050,0	760,5	617,9
3	40,0	120	40824,0	2000	4250,0	1860,0	7,8	325,4	35,0	1400,0	1074,6	1074,6
4	25,0	120	44089,9	2000	4260,0	1890,0	7,7	206,3	30,0	750,0	543,7	543,7
5	10,0	120	47617,1	2000	4270,0	1920,0	7,6	90,3	28,0	280,0	189,7	189,7
6	5,0	120	51426,5	2000	4280,0	1950,0	7,5	52,2	26,0	130,0	77,8	77,8
7	2,0	120	55540,6	2000	4290,0	1980,0	7,4	30,0	24,0	48,0	18,0	18,0
8	2,0	120	59983,8	2000	4300,0	2010,0	7,3	30,4	22,0	44,0	13,6	13,6
9	2,0	120	64782,6	2000	4310,0	2040,0	7,2	30,8	22,0	44,0	13,2	13,2
10	2,0	120	69965,2	2000	4320,0	2070,0	7,1	31,2	22,0	44,0	12,8	12,8

The corresponding parameters for the second type are summed up in Tables 3 and 4 below.

Table 3

Parameters of the first and second stages of the production cycle
for the third-party X-ray CT-tomography design

R&D		Pre-production		total	
Duration (year)	Costs (mln.rubles)	Duration (year)	Costs (mln.rubles)	Total time before sales (year)	Total costs (mln.rubles)
0	0,0	2	100,0	2	100,0

Table 4

Parameters of the third and fourth stages of the production cycle for the third-party X-ray CT-tomography design.

year	Sales target	Manufacture							Sales			Clear profit (mln.rub) Average salary of worker (rub)
		Number of workers	Average salary of worker (rub)	area (м2)	Number of workers	Average salary of worker (rub)	area (м2)	Number of workers	Average salary of worker (rub)	area (м2)	Number of workers	
0	0	0	0,0	0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-100,0
1	5	120	35000,0	2000	4200,0	1800,0	15,0	87,6	40,0	200,0	112,4	12,4
2	10	120	37800,0	2000	4240,0	1830,0	14,8	160,5	42,0	420,0	259,5	259,5
3	15	120	40824,0	2000	4250,0	1860,0	14,5	230,9	44,0	660,0	429,1	429,1
4	35	120	44089,9	2000	4260,0	1890,0	14,3	512,6	46,0	1610,0	1097,4	1097,4
5	40	120	47617,1	2000	4270,0	1920,0	14,0	574,3	48,0	1920,0	1345,7	1345,7
6	38	120	51426,5	2000	4280,0	1950,0	13,8	537,2	43,0	1634,0	1096,8	1096,8
7	20	120	55540,6	2000	4290,0	1980,0	13,5	285,2	41,0	820,0	534,8	534,8
8	10	120	59983,8	2000	4300,0	2010,0	13,3	148,3	39,0	390,0	241,7	241,7
9	7	120	64782,6	2000	4310,0	2040,0	13,0	107,4	37,0	259,0	151,6	151,6
10	6	120	69965,2	2000	4320,0	2070,0	12,8	93,5	35,0	210,0	116,5	116,5
11	2	120	75562,4	2000	4330,0	2100,0	12,5	42,7	33,0	66,0	23,3	23,3

12	2	120	81607,4	2000	4340,0	2130,0	12,3	43,0	31,0	62,0	19,0	19,0
13	2	120	88136,0	2000	4350,0	2160,0	12,0	43,3	29,0	58,0	14,7	14,7
14	2	120	95186,8	2000	4360,0	2190,0	11,8	43,6	27,0	54,0	10,4	10,4

The data were presented in graphical form and the curves of the life cycle for the first type of production are shown in Figure 1, for the second - in Figure 2. The main curves describing the life cycle (net profit) for the entire production cycle of the first and second types are depicted in Figure 3.

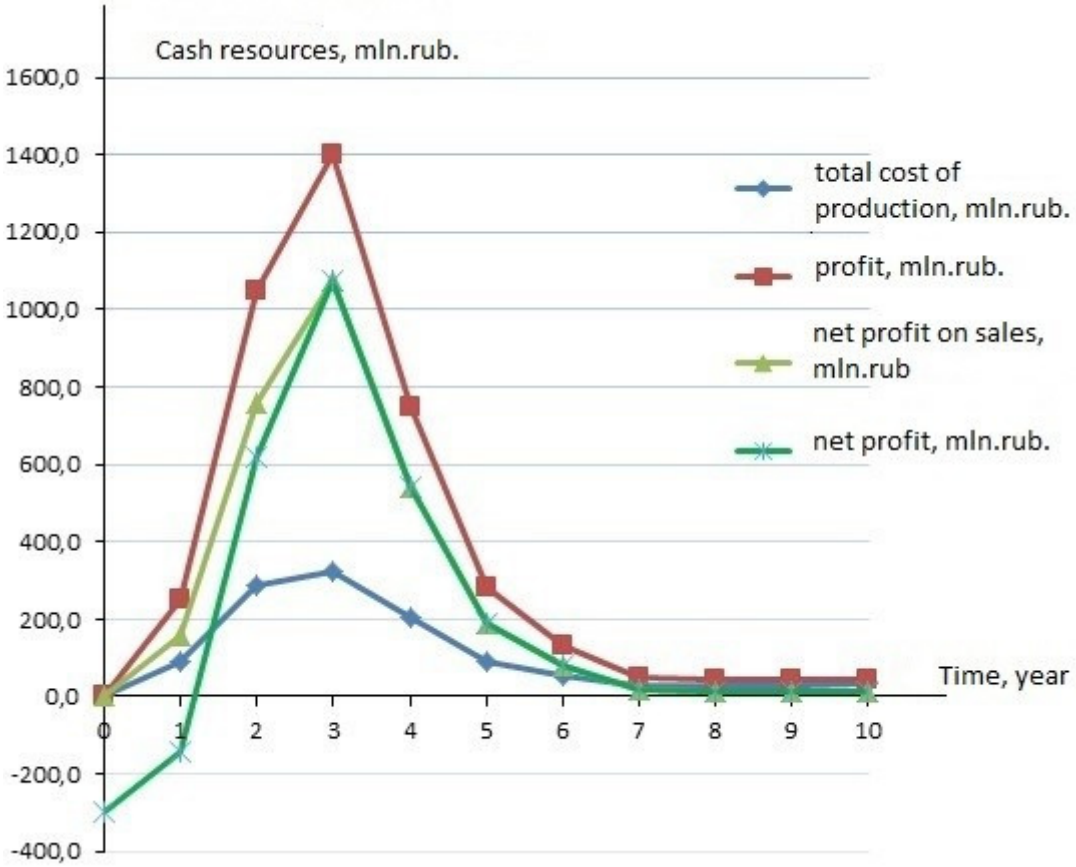

Fig. 1. The life cycle of the first manufacturing type

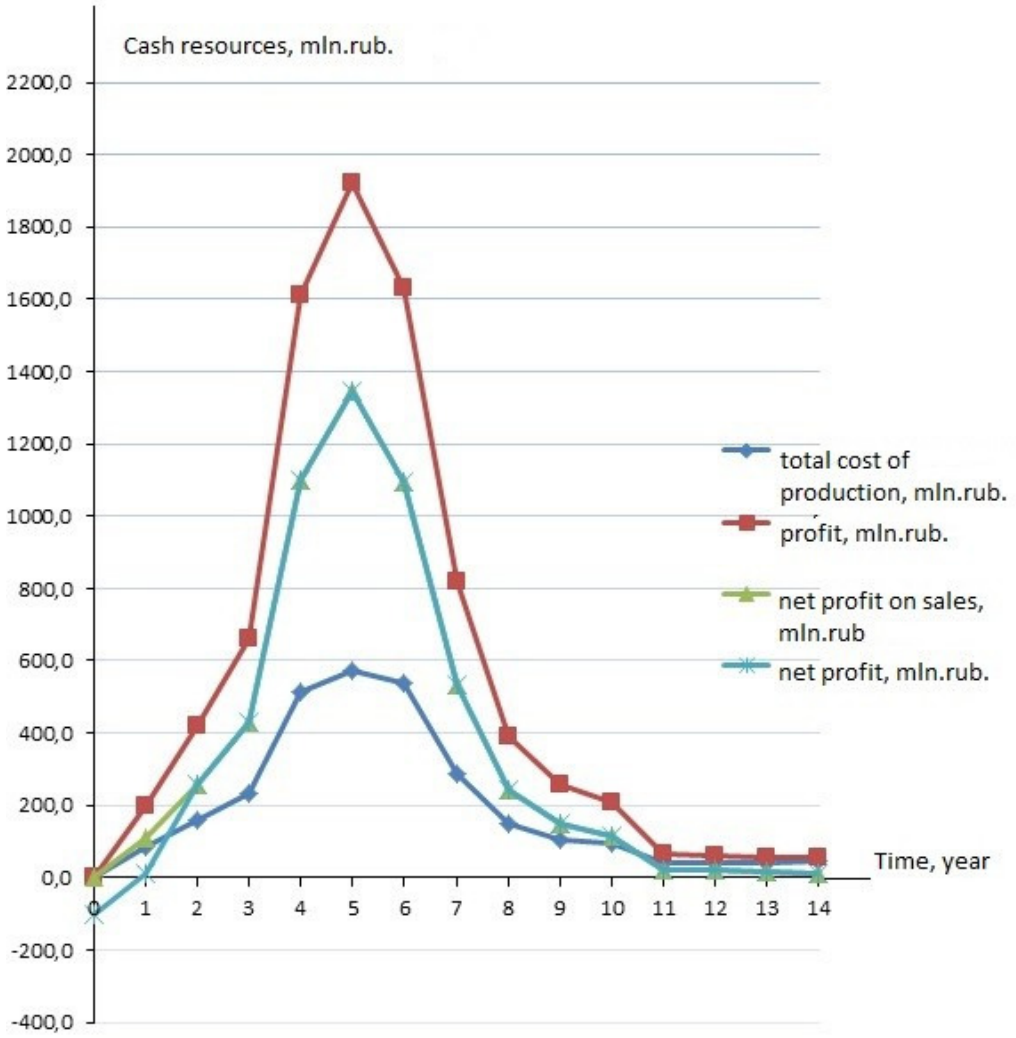

Fig. 2. The life cycle of the second manufacturing type

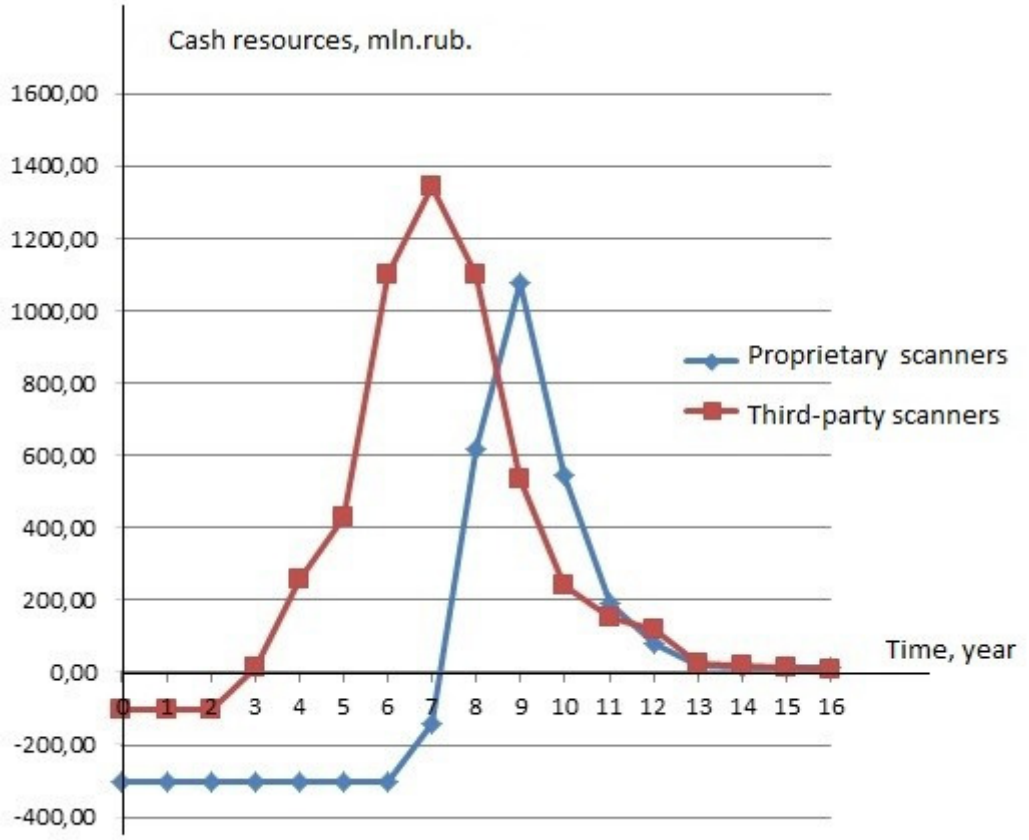

Fig. 3. Comparison of life circle of the first and second manufacturing type

A comparative analysis of two different types of X-ray CT-scanners production based on the modeling of the life cycle can yield conclusions about the feasibility of choice. For private commercial companies the second manufacturing type will be the most promising and profitable because in less time it would provide higher returns, rapid return on investment in the absence of significant investment in research and development and management of the entire production cycle with the help of the debugged developer's scheme. Due to the dynamics of the CT scanners market and the current high scientific and technological level of production, the first type (local development) may be promising in the long term (over 10 years) in the presence of qualified scientific personnel able to catch up with the technological progress and develop competitive topical products from year to year.

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