

Lean Production Supply Chain and QFD-Analysis in the Process of Healthcare

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Abstract- The research examines the process of providing medical care to patients, including patients with self-referrals (patients without referral), in the planning and diagnostic department and the trauma department of the city clinical hospital. The aim of the research is to determine the percentage of refusals of "self-converters", patients of the hospital who refused to be hospitalized after the initial examination and laboratory tests, reduce the cost of medical care, increase efficiency, consider options for reducing the percentage of refusals from hospitalization, patients in need of medical care. The result of the research expands the boundaries of the application of the Lean Production Supply Chain philosophy to the service sector. Improvement of the production and pre-production domain of medical services provision through the introduction of lean manufacturing and QFD-analysis, reduction of losses and analysis of the decrease in the number of refusals from hospitalization of "self-converters". The results of the research can be applied in internal and external processes of medical establishments and in organizations engaged in providing services to industrial enterprises. The use of lean manufacturing tools allows reducing all types of losses and servicing cycle time. The application of QFD improves the service process in a full life cycle, not only in the manufacturing field, but also in the service sector.

Key words: *medicine, Lean production, supply chain, value stream map, QFD.*

1 Introduction

The import substitution program also extends to the healthcare system of Russia. Improvement of its production capacity, speed and quality of work falls on all market participants, both consumers who are accustomed to a certain level of service (for example, the speed of execution of orders for necessary medicines), and the producer for increased demand or the development of new product offers. Government expenditure in Russia (as a percentage of GDP) for 2016 amounted to 3.6%, which is 4.7% less than in the US and Europe (excluding Ukraine). At the same time, the state's spending on health care is increasing in both monetary terms and in relation to GDP [9], [11], [12]: Another important indicator will be the reduction in the number of hospital and outpatient organizations, and, consequently, the number of beds in hospital organizations, with the growing attendance of outpatient and outpatient organizations by patients.

This means that with a decrease in production capacity and capacity of organizations, there is an increase in the flow of patients. Medical staff, in this case, comes to the need to improve the effectiveness of their activities. [3], [9], [14] Statistical data indicate the need to optimize all types of resources of medical institutions. The problem of optimizing costs in medicine and improving the quality of care in medicine is used both in the joint application of Lean and 6 sigma. The results of the research are reflected in the works of the most famous representatives of this direction of Tom Sidel, Mark Graban, and Joseph Juran. In the US, the magazine U.S. News & World Report published a list of the best hospitals in 2016-2017, many of which used the concept of lean supply chain manufacturing [3]. In Europe Lean supply chain tools in medicine are being introduced in Germany, Spain, Denmark and other countries. In Russia, the healthcare support program is aimed at improving the health of the population and the performance of health care organizations in project "Lean Polyclinic"[5].

2 Methods

Creating a lean environment in the provision of health services is aimed at minimizing costs in the process of specifying services and maximizing profits. Significant advantages of LP in comparison with other methods of increasing business efficiency are minimal or missing costs for the project to improve the internal system of the organization. The effect of such changes has an impact on material resources, indirectly affecting the end consumer [2], [3], [7]. Efficiency in the implementation of LP is:

- Reducing the cycle of the service in order to increase customer satisfaction;
- Improving the value stream;
- A reflection of the financial results from the implementation of the financial performance of the organization.

Improving the internal cycle of service delivery, pre-production, work with the market and client-oriented often remains outside the changes. As you know, the market economy forces you to stretch the production system by building a chain from the consumer to the production. In the competition for the first places in the sales ratings, those organizations whose products are manufactured on the principle of stretching,

anticipating the expectations of consumers are fighting. One of the methods affecting the development of the pre-production sphere is the QFD method. The QFD technique is a study of the customer's voice in the process of designing or finalizing an existing product offer. The received data are entered in the matrix "House of Quality", are ranked and, by statistical calculations, are presented to a visual table with coefficients of correlation of the importance of technical characteristics, needs and results of benchmarking of key competitors (10). Introducing QFD and LP collectively enlargement efficiency should be considered as:

- Improving the value creation process in the production and pre-production areas;
- Attracting new customers - increase profits;
- Reducing the costs of the service delivery process.

3 Results

The study was carried out in the Planning and Diagnostic Department and traumatology of the 7th Clinical Hospital of the city. The PDO is a department with examination. Patients who did not follow the direction of a doctor from another medical institution and not through emergency care are called "self-converters". The most acute problem is the self-reversal of citizens who refused to be hospitalized. Research costs for these patients are not reimbursed by the Ministry of Health and lead to major material and non-material losses. Propose to consider the process of medical reception of a patient without referral in the Diagnostic Unit.

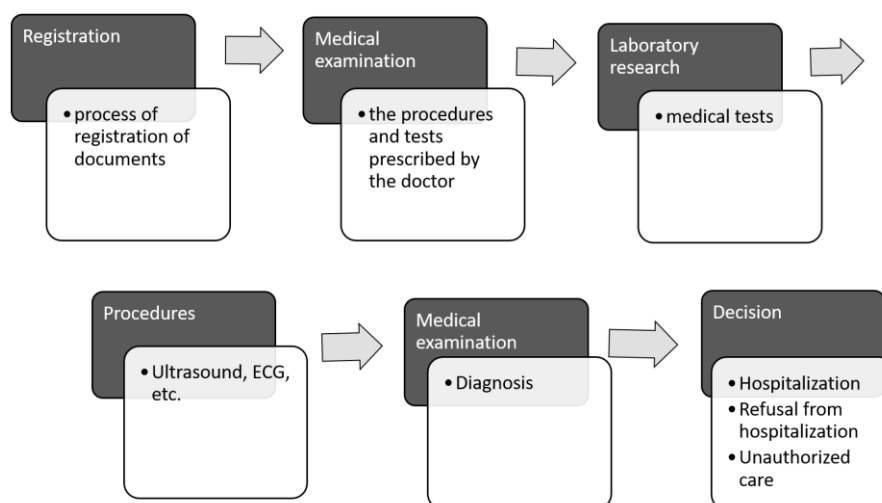


Fig 1. Patient admissions process

During the study, medical care was provided to 89 people (23 in traumatology and 66 in examination rooms). Of these, 33 patients without referral. From the table below it could be seen that only 7 people were hospitalized from self-converters. 17 people in need of hospitalization are not hospitalized at will. More than 50% of patients admitted to self-reversal are not

hospitalized, which means that all funds spent for diagnostic researches and first aid to the patient will not be reimbursed to the medical institution. The following is a graph of the movement of patients after a medical examination or first aid, received by self-reversal:

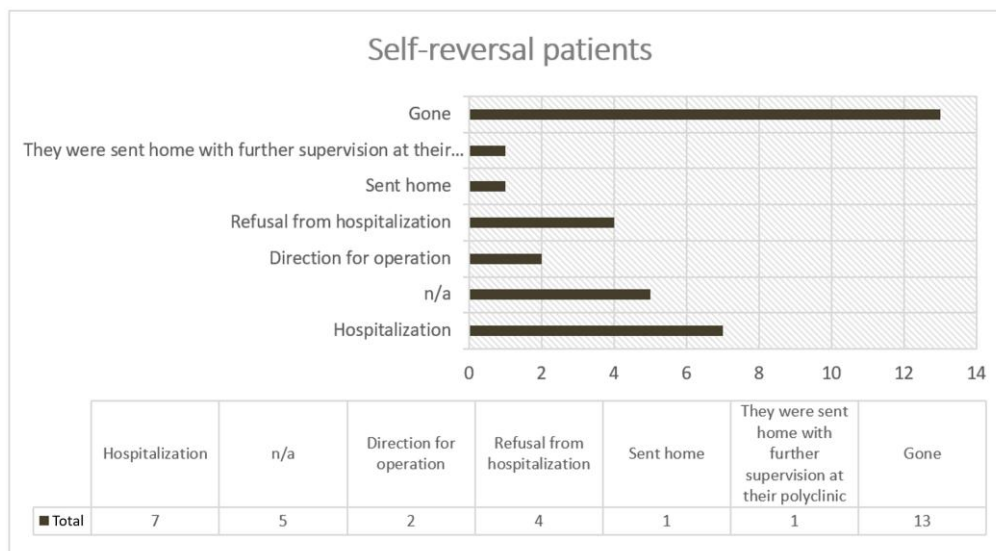


Fig. 2. Self-reversal patients

The time of the tact of patients receiving self-reversal was calculated. The clock time is 72 minutes while the loss is 27.3 minutes (38%). The added value is 44.7 minutes. Thus, the main causes of expectations are

identified. An analysis of the causes of the emergence of patients' expectations is schematically depicted by means of a diagram of cause-effect relationships [1].

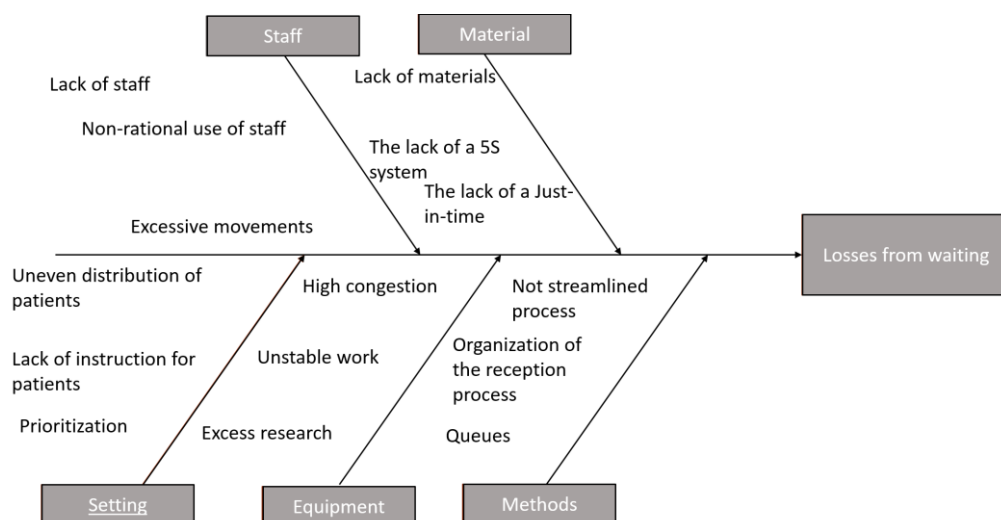


Fig.3. Ishikawa's diagram. Causes and consequences of losses from patients' expectations.

Suggestions for solving problems with the fact that the polyclinic loses when patients refuse without referral from hospitalization:

- Write directions to the hospital by place of residence.
- Improve the contractual relationship on the transfer of information about the patient.
- Create a "Self-Transferred Patient Bank" to provide information to the Ministry of Health with monthly guidance on the costs of these patients. To

enter data into the computer system. (to select self-converters with blanks of another color).

Consider the possibility to automatically send data to the clinic in the community as follows:

- General information system,
- Using the official e-mail of the hospital,
- By Russian Post (to calculate the expediency of sending options).

In accordance with the main identified reasons for expectations, including the loss of time from waiting in line, filling out papers, waiting for a doctor,

the basic tools of Lean supply chain Manufacturing are compared:

- Spaghetti Diagram for the study of unnecessary movements of patients, doctors, nurses.
 - 5S – the location and storage of medical supplies, especially in warehouses.
 - Calculation of the cost of research.
 - Visualization of standardized medical procedures.
 - Standardization of patients with typical diagnoses.
 - Development of the Kaizen system.
- Following the goals the organization's personnel goals, the application of innovations.
- Application SCRAM meetings, tool 5 why, report format A3, etc.
 - Calculation of resource efficiency.
 - The most acute problem is the self-reversal of citizens who are not related to this hospital, as well as the refusal of citizens, from further curing in the hospital of the organization, which entails unnecessary costs for the research of patients not going to continue medical care.

After examining the basic procedures conducted by self-converters during January 2017, it was revealed that of the 472 people who received assistance in neurosurgery, 132 people entered the medical facility by self-seeking for medical help. The assigned

procedures are sorted by unique values in external prices. The analysis of losses of medical establishments at the market cost of research was carried out [15]. Amounts are as follows: CT – 415,400 rub., MRI – 5,000 rub., X-ray – 35,700 rub., US – 24,000 rub. The total cost of maintenance in the past month amounted to 480100 rubles. Health care workers noted that seasonality in the department of neurosurgery is not available, this means that for the year projected losses amount to 5,761,200 rub. and will not be reimbursed for medical institution for assistance. These data require additional calculation of the following resources:

- Consumables.
- Equipment depreciation.
- The remuneration of staff who does the medicine procedure.
- Remuneration of maintenance staff (for example, equipment repair).
- Wages of janitor.
- Public utilities.
- Rent and maintenance of facility.
- Remuneration of laboratory staff depending on the conducted research.

For a more visual representation of the amount of time loss, consider the percentage of loss from reception time in the departments of traumatology and observation.

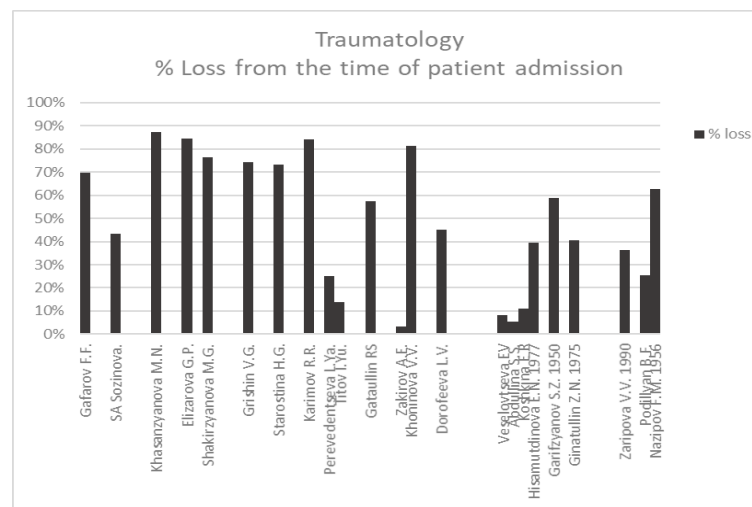


Fig. 4. Traumatology, % of losses from time of reception of the patient.

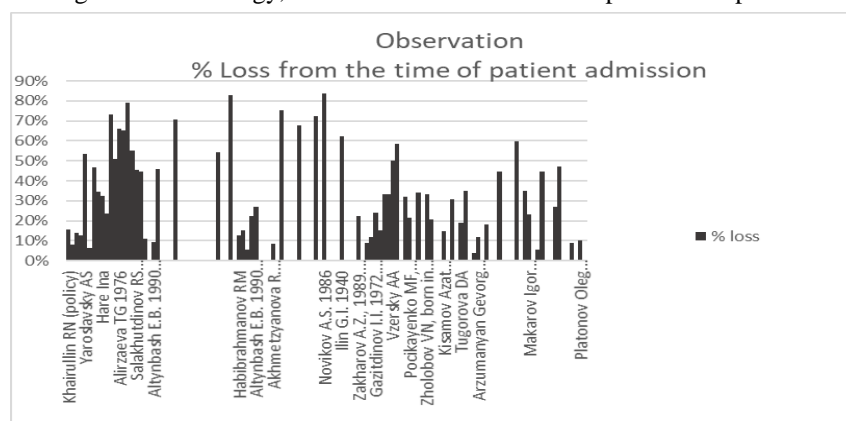


Fig. 5. Observation, % loss from the time of reception of the patient.

Exploring the value chain in the process of providing health care services to the consumer, the following types of losses are identified:

- Losses due to the extra processing steps (e.g., long registration and the lack of efficient information systems);
 - Overload and downtime (the unpredictability of emergency admission of patients, lack of temporary admission schedule);
 - Overproduction (excessive diagnosis, uninformative procedures for this diagnosis).;
 - Lost time for waiting (waiting in queues);
 - Losses due to excessive transportation (both within one medical institution and between institutions)
 - Losses due to surplus supplies (stocks of medicines, medical equipment, lack of FIFO));
 - Defects. For example, incorrectly diagnosed, refusal of equipment or unqualified doctors.
 - Unrealized creative potential of employees.
- Among them, loss of ideas, lack of involvement, the

desire for improvement, the acquisition of experience or self-control.

The analytical review of the professional medical literature revealed the main results of the work of foreign and Russian researchers (including the "Lean Polyclinic" project) on improving medical care by Lean supply chain Manufacturing tools [6], [8]:

- Reducing the waiting time.
- Reduction and prevention of mistakes.
- Decrease of costs for utilities.
- Inventory reduction.
- Optimization of the schedule of doctors, etc.

In the context of research, to identify weaknesses in the organization, the main reasons for patients' expectations for medical care have been analyzed.

The main reason for waiting is the queue and the completion of papers - workflow.

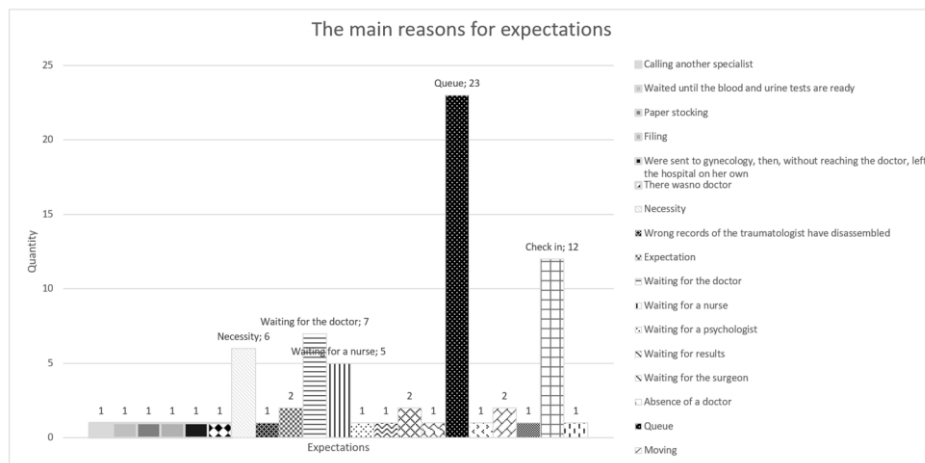


Fig. 6. The main reasons for waiting a long time at the reception.

In the course of the research, the process of receiving patients was also closer looked in the department of traumatology.. The average registration time in the registry is 12 minutes (10 of which are queued). Then the patient goes to the reception to the traumatology, then goes to the procedures and tests, returns with the

analysis to the traumatology and after the traumatology appoints the necessary treatment. Given the specificity of the flow of patients, we will build up a value stream map for the separation of traumatology. Value stream map:

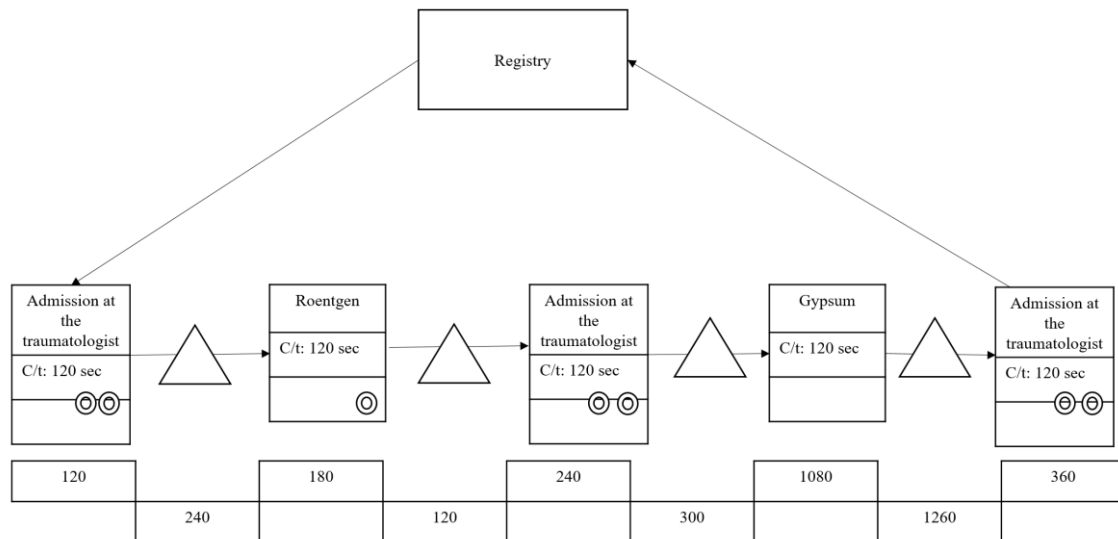


Fig. 7. Value stream map of the current status.

The map shows the progress of patients at all stages of treatment. The supplies indicated in the diagram by triangles represent the time costs - waiting for the next stage by the patient. The stocks include the time spent on moving between points of value creation. The total creation time of the added value is 1980 sec., the waiting time is 1920 sec., which confirms and exceeds the calculated loss percentage. The losses from the total time are 49.2%. The time of the production cycle is

3900 sec. When drawing up a map of the future state, it is proposed to reduce expectations between the processes by reducing the number of tricks at the trauma clinic. The application of standardization for the most common complaints in trauma will allow patients to be sent to research (tests, X-rays, etc.), and standardization of procedures will avoid additional traumatologist control at the final stage. Value stream map of the future status:

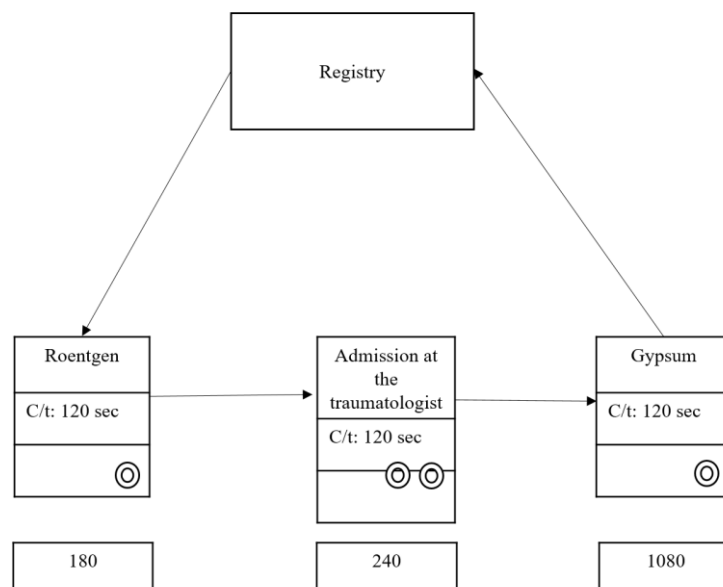


Fig. 8. Value stream map of the future status.

The time of the production cycle will be reduced from 3900 sec. to 1500 sec. for 1 patient. The dissemination of this practice to other departments and processes, including PDD involved in creating value added, will maximize the effect of lean supply chain tools [16],

[17]. As a result of the research, a model of the resources spent for the provision of services is proposed, with the introduction of lean supply chain manufacturing tools. The pre-production, production stages and the after-sale service phase are shown,

showing the dependence of the reduction in the use of material resources from the use of Lean Production

supply chain tools at all stages of the service life cycle. Model outline:

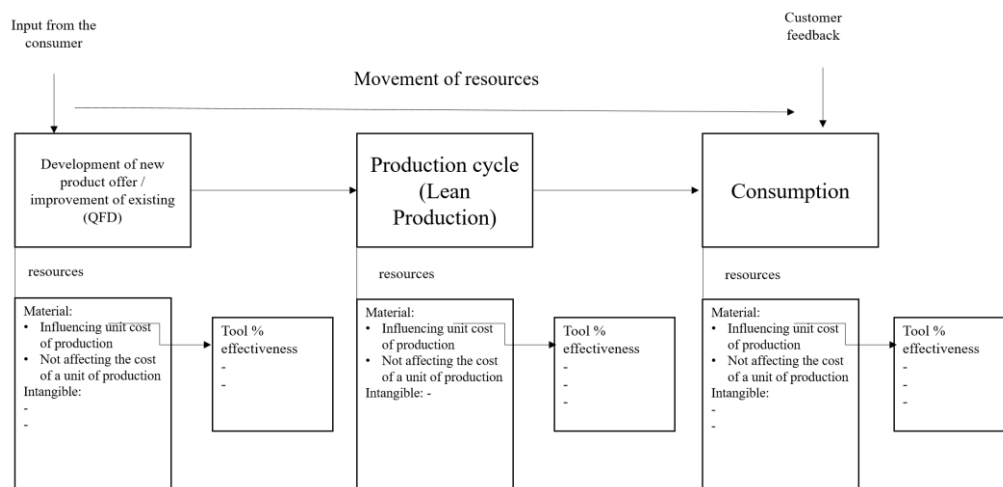


Fig. 9. Model of resources used for the service delivery process

4 Discussion

Analyzing the schematically compiled cause-effect relationships of losses from expectations, the problem of eliminating losses and working on weaknesses is suggested to be solved by using lean production supply chain tools, as a technique that does not require monetary investments. Lean supply chain manufacturing is aimed at the internal process of service delivery, and when creating a new quality of an existing service or a new service, a joint approach of LP and QFD is proposed. Improving the quality of medical services through the use of QFD-analysis will help to solve the problem of patients refusing hospitalization. A variant is proposed for calculating the cost of the projected service by making an approximation [10]. The data obtained during the research helps to identify all the losses that arise in the process of patient care, as well as understand the causes and eliminate them using the most effective instruments, including lean supply chain manufacturing tools. This means that the degree of satisfaction provided by the procedures for the patients of the medical institution will increase and hospitals will be able to increase the flow of patients of their number without reducing the processing time adding value, for example, medical examination by a doctor. The presented model suggests paying attention to the existing material and non-material costs of resources. Efficiency in the implementation of LP is reflected in the short-term financial resources of health facilities used for ongoing activities, and is the following:

- Reduction of the production cycle in order to increase the customer's positive attitude.
- Streamlining the value stream.

- Reflection of financial results from the introduction on the financial indicators of the organization.

- Improving the quality of products.
- Increased staff involvement.
- Reduction of costs of all resources.

5 Summary

In the course of the research, the losses that occur in a medical facility when servicing patients who have been self-addressed will not be reimbursed for payments for resource costs for the procedures performed. The journal of medical and research procedures of patients, including self-converters, has been analyzed, material and non-material losses have been identified. The losses that occur during the provision of medical care in the planning and trauma departments are determined. The data obtained on the basis of the generated value stream charts show the need for QFD and LP tools to reduce the resources spent on medical care and improve the efficiency of medical personnel. A model of resource costs and the use of LP tools for the process of medical care in the implementation of the philosophy of lean medicine is presented.

6 Conclusions

The implementation of LP in conjunction with the methods of structuring quality functions will not only reduce costs, improve the production structure, but also significantly improve the quality, volume of services provided, allow to expand and transform the configuration and types of medical care. The result of the research expands the scope of application of Lean

supply chain Manufacturing philosophy to the service sector, not only for the purpose of commercialization of the service for the end user, but also for the use of a third party, reimbursement for the costs of examining patients seeking emergency care without referral from other health facilities. The joint integration of lean supply chain manufacturing and QFD into production and pre-service delivery cycles will increase the attractiveness of the medical facility for the end user, third parties, accelerate the patient care cycle and reduce the number of refusals from further treatment in hospitals. As a result, the costs for the main resources of the health care institution will be reduced - utilities, costs for inefficiently conducted research, wages, medical supplies and tools.

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