

APPLYING STATISTICAL TOOLS TO QUALITY CONTROL OF INDUSTRIAL GARMENT LINES - THE KEY TO REDUCING COSTS AND IMPROVING THE EFFICIENCY OF GARMENT ENTERPRISES

Nguyen Van Duc ¹, Nguyen Viet Dung ², Do Quang Khang ³

¹Nguyen Van Duc (Fisrt Author) - Hanoi industrial textile garment university

²Nguyen Viet Dung (Corresponding Author) – Thai Nguyen University of Economics and Business Administration.

³Do Quang Khang - Academy of Communication and Journalism

ABSTRACT

This article aims to introduce to industrial garment enterprises in Vietnam the research results of applying a number of statistical tools to quality control (QM) at garment enterprises in Vietnam. The project's product is a modern garment line management software with a modern statistical tools running completely automatically on the Microsoft Excel platform. With a friendly and flexible interface; no installation and low operating costs; Visual quality control reports with valuable information, this system will help garment enterprises improve the efficiency of quality control, thereby contributing to building and strengthening the brand. Quality control, statistical tools, industrial garment line.

Keyword: *Quality control, Statistical tools, industrial garment line*

1. INTRODUCTION

In a fiercely competitive environment, each enterprise must have an appropriate policy to create its own brand. Currently, Vietnamese garment enterprises mainly produce by pure processing method, with low revenue in the context of labor competition and increasing labor costs. Therefore, reducing production costs is a matter of great concern to enterprises. The application of a quality control system according to international standards or the application of modern statistical tools to improve quality is one of the preferred solutions chosen by many enterprises to control quality, minimize waste due to goods repair, meet the needs of customers, improve the position and reputation of enterprises in the market.

In fact, there are a number of enterprises that have studied and applied the statistical tools to the quality control process. However, the survey shows that the application of these tools is mainly researched and applied by enterprises themselves, there are not standard instructions for this works; Most of enterprises use these tools ineffectively, or fail to apply them to their quality control system, fail to apply them synchronously, leading to unresolved error rates, or incomplete

statistics, there exists a situation where many system errors arise, it is costly and wastes resources to overcome etc. Therefore, it is necessary to have a comprehensive and representative study on the application of statistical tools in quality control on production lines at garment enterprises. Faced with that situation, the research team at Hanoi Industrial Textile Garment University conducted the topic **"Research and apply some statistical tools in quality control at industrial garment enterprises of Vietnam National Textile and Garment Group"** to find appropriate quality control solutions to improve product quality, meet customer requirements, reduce costs caused by defective products and defects for industrial garment lines.

2.THEORETICAL BASIS FOR APPLICATION OF STATISTICAL TOOLS IN QUALITY CONTROL

2.1. The concept of quality control and quality control in industrial garment enterprises

According to the international standard ISO 9000: "Quality control is a set of activities of the general management function for the purpose of setting quality policy, accountability goals and implementing through measures such as:

Planning, control, assurance and improvement of quality within the framework of a quality system”.

Quality control in industrial garment enterprises is coordinated activities to orient, check, control, maintain, ensure and improve quality in the process of industrial garment production.

2.2. Principles in quality control

Principle 1: Customer-oriented approach. Product quality of an enterprise is customer-oriented; Enterprises produce and sell what customers need, not what they have.

Principle 2: Leadership. Quality performance cannot be achieved without the full commitment of senior management. Organizational leaders must have a vision, build clear, specific and customer-oriented values.

- Principle 3: everyone's participation. To achieve results in quality improvement, the skills, enthusiasm, and sense of responsibility of employees play an important role. Organizational leaders must create favorable conditions for all employees to learn and improve their knowledge, professional qualifications, and management.

- Principle 4: Process-oriented approach. The desired outcome is effectively achieved when the resources and activities involved are managed as a process. The process-oriented customer-oriented approach results in tighter systematic quality control, ensuring that all processes are monitored and controlled by the system. This is aimed at improving quality to satisfy customer needs in the best way.

Principle 5: Evidence-based decision-making. All decisions and actions of a quality control system to be effective must be based on accurate data and information analysis. Decisions should not be made basing on any inference.

- Principle 6: continuous improvement. Quality is oriented by customers while customer needs and wants are always changing according to the tendency and wish to satisfy their increasing requirements. Therefore, quality always needs innovation. In order to have innovation and improve quality, it is necessary to make continuous, non-stop improvement.

Principle 7: relationship management. Organizations need to build collaborative relationships internally with external parties to

achieve common goals. Internal relationships, create internal solidarity, promote cooperation between leaders and employees; Create network relationships between departments of the organization to increase flexibility and responsiveness. External relationships are those with customers, suppliers, competitors, training organisations, regulatory agencies, local authorities, etc. that facilitate or connect the enterprises with the markets.

2.3. Statistical tools in quality control

2.3.1. Check sheets

Check sheets are a means of storing data. It is usually pre-printed forms with criteria to be monitored during operation, making it easy to record and analyze test results.

The check sheets monitor events over time, but can also be used to track event counts by location. This data can be used as input to a Pareto chart, etc.

2.3.2. Flow charts

Flowchart is a form of representing the activities of a production/service process through block diagrams and certain symbols.

Flowcharts are used to identify and evaluate whether activities are adding value, and then change or eliminate activities that create low or no added value to eliminate waste, etc. Flowcharts represent the workflow visually to connect the steps and aim to simplify the process. In addition, it also helps to make the process clear, easy to follow and encourages employees to work in groups and reach consensus within the organization.

2.3.3. Cause and Effect Diagram

A cause-and-effect diagram (fishbone diagram) shows the relationship between a cause and the cause of that result. The results are the quality indicators that need to be monitored and evaluated, and the causes are the factors affecting that quality indicator.

Cause-and-effect diagrams are used to find and identify the causes of product quality, service, or process problems. From there, propose measures to remedy the nonconformity or improve and improve the quality.

2.3.4. Pareto chart

Pareto chart is a column chart that reflects the collected the quality data, arranged in order from highest to lowest, indicating the issues that need to be prioritized to be solved first.

Pareto charts are used to identify the importance of each problem, prioritize issues to be solved first, and show the results of quality improvement activities after they have been implemented.

2.3.5. Histogram

Density distribution histogram is a type of bar chart that shows graphically the changes and fluctuations of a set of data according to certain shapes.

Histograms are used to monitor the distribution of product/process parameters. From there, evaluate the capacity of the process. The histogram shows the frequency of the problem (collected through the check sheet). Based on the shape of the density distribution histogram gives accurate conclusions about the normal or abnormal state of a process.

2.3.6. Scatter Diagram

A scatter diagram is a graph that shows the relationship between cause and effect or between factors affecting quality. The diagram presents the pairs as point clouds. Relationships between contact metrics are inferred from the shape of those clouds.

Scatter diagrams are used to solve problems and determine optimal conditions by quantitatively analyzing the cause-and-effect relationship between the variables of two factors.

2.3.7. Control Chart

A control chart is a graph that shows graphically the change of a quality criterion to assess whether a production process is in an acceptable or controllable state.

Based on the control chart indications, process fluctuations are detected to ensure that: normal or abnormal; controllable or uncontrollable; acceptable or unacceptable. Thereby, it is possible to identify the causes of the abnormality to take remedial measures to restore the process to an acceptable state or improvable to bring the process to a new, better state.

2.4. The relationship between the statistical tools in the quality control of industrial garment products

The application of statistical tools to quality control is necessary. Each statistical tool has its own effect. To apply statistical tools to quality control, people do not use a single tool, but often combine two, three or four tools together, depending on the purpose. The choice of which tool to combine in problem solving depends on the management goals, understanding and experience of the implementer to maximize efficiency. Depending on the level of error, the location of the error in the production process, it is possible to combine statistical tools according to different plans.

Selecting statistical tools into quality control needs to master the following principles:

Firstly, it is required to meet the quality control requirements of enterprises.

Secondly, it is required to help enterprises make accurate and timely quality decisions.

Thirdly, is required to produce an report automatically, helping the management department to grasp the quality situation quickly and accurately.

Fourthly, is required to be feasible for enterprises to easily implement.

In industrial garment production, the quality issues that are often concerned by enterprises are: management of defective products, error stages, error types, thereby finding the cause to solve the problem right in the production process. In order to meet the general needs of enterprises, the quality control process needs to combine the statistical tools according to the combined process as shown in Figure 1 with 5 types of used statistical tools and the orders as follows:

Step 1. Use a flowchart to define check sheets (this step is usually predefined).

Step 2. Use the check sheets to collect test data during the process.

Step 3. Use the control chart to determine the number of defective products in the process.

Step 4. Use the Pareto chart to identify the fault stages, the main types of errors.

Step 5. Use the cause-and-effect diagram to analyze the cause of the error

In addition, in fact, there are cases where a parameter in the process needs to be standardized such as weight, length, etc.; When it wants to check, it is required to have to choose the distribution chart to determine the stability of that parameter.

Thus, the Check Sheet is one of the important tools indispensable in all cases. It is combined with 1 or more other statistical tools to promote the effectiveness of quality control on garment lines.

3. ACTUAL SITUATION OF APPLICATION OF STATISTICAL TOOLS INTO QUALITY CONTROL IN PRODUCTION LINES OF ENTERPRISES

To assess the current status of the application of tools in quality control at garment enterprises at Vietnam National Textile and Garment Group, the research team synthesized answer sheets from 25 selected enterprises to survey representatives by region, size, and region and manufactured goods. The results are shown in Table 1 below:

Table 1. The statistical tools applied by enterprises to the quality control of the garment line

Statistical Tool	Statistical Tools used by Enterprises			
	Yes		No	
	Quantity	%	Quantity	%
1. Flow chart	25	100	0	0
2. Check sheet	25	100	0	0
3. Pareto diagram	9	36	16	64
4. Cause and Effect diagram	8	32	17	68
5. Histogram	3	12	22	88
6. Scatter diagram	0	0	25	100
7. Control chart	10	40	15	60
8. Other tools etc.	5	20	20	80

Source: Summary of research team

Table 2. Orders of applying statistical tools in quality control in garment lines

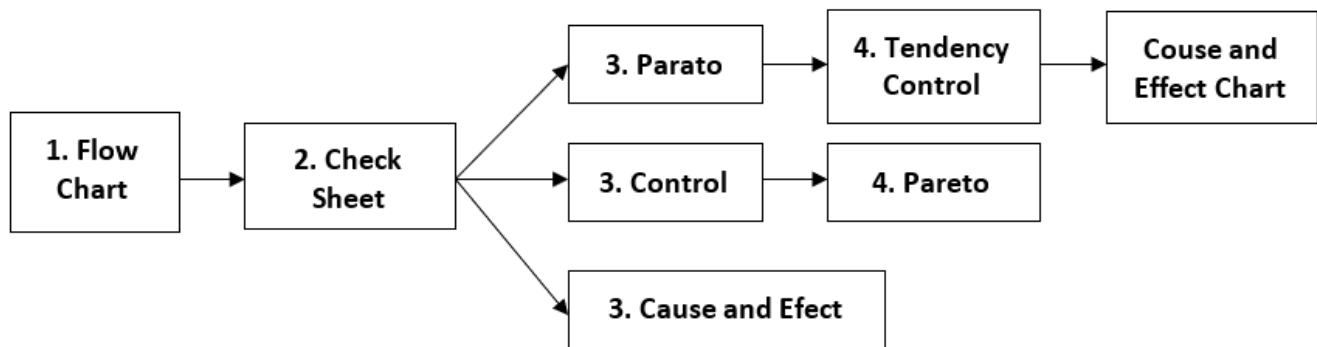
Statistical Tool	Actual implementation orders						
	1	2	3	4	5	6	7
1. Flow chart	11						
2. Check sheet		10					
3. Pareto diagram			7				
4. Cause and Effect diagram			1	4			
5. Histogram			1				
6. Scatter diagram							
7. Control chart			4	4			

Source: Summary of research team

On the basis of the survey results, the research team has summarized into a number of options for

combining the statistical tools in quality control at the enterprise's garment lines as follows:

Figure 3: Methods of combining statistical tools in quality control in garment lines



Source: Summary of research team

The tools most effectively used by enterprises are: flowcharts and check sheets, followed by control charts, Pareto charts, fishbone charts, histogram; Scatter charts are almost never used by enterprises because they do not have much effect and the application of these two tools is quite complicated.

Thus, the use of statistical tools for quality control helps managers always control the production process. However, in order to promote the effectiveness of the statistical tools, the use of these tools needs to be designed appropriately, the tools must be linked through technological equipment, and the data is regularly controlled. The collection of data must be accurate and complete according to the management objectives, especially the check sheet must be clearly and fully designed with all types of errors, fault locations, total number of errors, and error types to provide information to different management goals.

However, the use of statistical tools in quality control, if implemented seriously, will bring high efficiency to the quality control process. Through the application of pareto charts, cause-effect diagrams, and control charts of enterprises, the test results have been shown on various graphs, however, many quality control objectives have not been shown. In the graphs, it is not possible to show the warning conclusions for the results obtained compared to the allowed standards in the test objectives to help the manager to see the problem that needs to be solved. At the same time, the use of charts has not been implemented regularly, only used in the cases of weekly reporting at the end of the line, not yet reported

for the on-line checkpoint by time zone, by day, by stage and by types of errors, etc. so the effectiveness of the statistical tools in quality control has not been promoted right in the production process.

4. SELECTION OF STATISTICAL TOOLS IN QUALITY CONTROL OF INDUSTRIAL GARMENT LINE

The selection of statistical tools to incorporate into the quality control reports depends on the quality control objectives at the checkpoints. According to the general process, quality managers always check the quality situation from overall to detail. To achieve this goal, the statistical tools will be selected from the flowchart to determine the test points and test tasks, respectively; check sheets collect data during the inspection process; control charts represent the quality status of the stages in the process; Pareto charts arrange the order of the error steps, or the error types from high to low to determine the main point of failure, the main type of error; Cause-and-effect diagrams are another choice for analysis to find potential causes. These tools will be an effective means of supporting the quality control work to be ensured quickly and effectively. In addition, there are many cases where the parameters of the process do not have the necessary stability, to check this problem in addition to the flow chart and check sheet, the distribution chart must be selected to make quality reports. Quantify the normal distribution of parameters to easily find the cause and suggest early solutions such as checking the parameters of the laundry, weighing the weight of feathers or stuffed in jackets, etc.

The essence of quality control is the process of checking, detecting, preventing and avoiding errors that may occur in the production process. Therefore, to ensure the safety of the production process, the application of statistical tools to support the quality control of enterprises is necessary. However, the selection of tools to meet the quality requirements, the application of statistical tools must be arranged and used according to a reasonable process, ensuring the promotion of the effectiveness of each statistical tool, and at the same time helps the quality control process of enterprises to be most convenient and effective.

The research team proposes to choose 6 types of statistical tools that should be used: flowcharts, check sheets, control charts, pareto charts, cause-effect charts and distribution charts, which are enough for enterprises to analyze all kinds of quality reports during the production of industrial garment products.

In order to determine a reasonable application process of statistical tools, it is necessary to define management objectives at the checkpoints in the production process. At this point, the selection and arrangement of tools will be done.

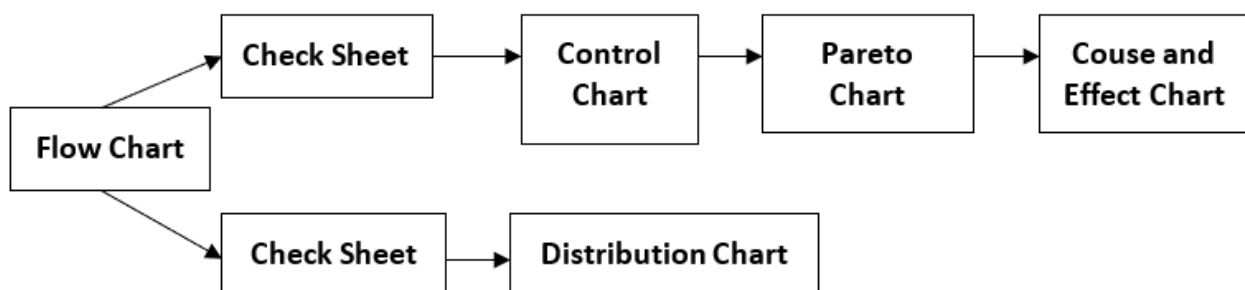
In the industrial garment production process, there are few stages of production such as cutting and finishing; At the inspection points when detecting defective products, testers or managers can easily identify the location of the defect and the main types of defects. The most appropriate use of statistical tools in this stage is to use flowcharts to define tasks and checkpoints, check sheets to control process quality, and cause-and-

effect diagrams when identifying critical problems for finding the cause of the error. In addition, a column chart can be used to compare error rates between days and weeks etc. to help managers assess the progress of quality control work at these stages.

In addition to the above two stages, garment is the most important stage and must manage the most stages. Therefore, the quality control at this stage is quite complicated. The use of statistical tools to support quality control at the garment stage is necessary and effective. The goal of testing at this stage is to control the stability level in the process, detect errors at the test points, and synthesize the number of errors in the test points to identify important failure points that need to be resolved immediately. In addition, synthesize the number of errors between the checkpoints to compare and evaluate the stability of the processes.

Errors arising in the production line often occur with many different problems such as the number of defective products, the number of defects, or the types of defects that appear at many stages or several stages of testing etc. at different stages in the production process. Through the study and analysis of the current status of the quality reports of the garment enterprises, the effects of each selected financial structure; The research team proposes a number of process types that combine different statistical tools to be able to analyze different types of errors to help enterprises apply them to analyze quality problems in a specific production process as follows:

Figure 4. Process of combining statistical tools



Source: Simulation of the research team

The selection of the process of combining appropriate statistical tools depends on each management goal or depending on each problem

in order to analyze the results of the quality control at a specific process according to one of the two branches as follows above.

5. DESIGN OF SOFTWARE FOR APPLYING STATISTICAL TOOLS IN QUALITY CONTROL

On the basis of survey and analysis of the current situation of using statistical tools and applying information technology to quality control at garment enterprises of Vietnam Textile and Garment Group, the research team has built a quality control system for industrial garment lines with the application of statistical tools and run completely automatically on MS Excel platform. When using, the user only needs to update the data on the Check sheet in-line or at end-line; The system will automatically make statistics, calculate and give reports with statistics and visual images, combined with andon warning lights in statistical tables such as:

- Quality report by: time zone, day, week, month.

- Report quality comparison between lines by: day, week, month or comparison of each line between: 2 days, weekdays, weeks of the month.

- Check product parameters (distribution chart).

Currently, quality control software is available on the market apart from language differences; The cost of using is high, the quality reports are discrete, users have to copy and present it again to be able to use it. But all of these have been thoroughly addressed and taken into account when designing the system. The quality

reports that this system gives are both visual (charts, color warnings), quantitative (statistics, calculations) and full of necessary information. Users only need to print and read in 1 report to have all the information related to the problem to be solved all-in-one.

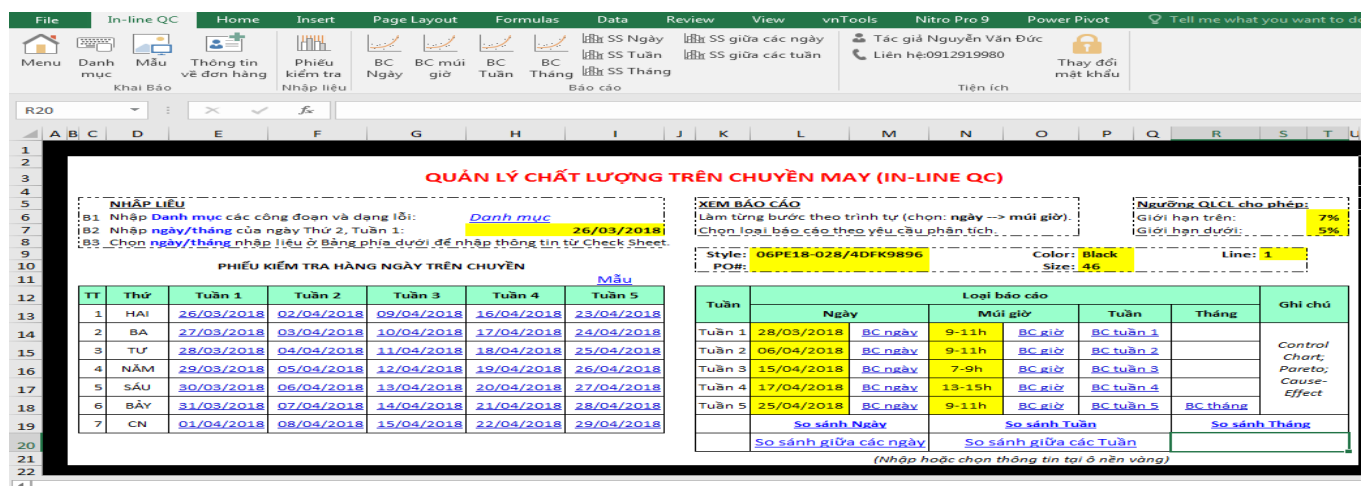


Figure 5. Main interface of garment line quality control system

Source: screenshot of garment line quality control system

The interaction between users and the system is quite flexible. At any function of the system, users can easily switch to another function through the shortcut buttons designed on the ribbon bar arranged with the function menu of MS Excel without returning to the main scontrol menu. At the same time, the Vietnameseization of all command buttons and reports helps quality control staff with limited English proficiency still be able to use this system.

The general structure of quality reports by time zone, day, week and month includes 3 parts with

3 important statistical tools: control chart, pareto chart and cause and effect/ fishbone chart. In addition, the system also provides full data on the fault stage, the name of the worker performing the stage, the type of error sorted in descending order; The data that exceeds the permissible quality threshold according to the regulations of the enterprise are displayed by andon lights for easy identification by users.

As for the cause and effect/fishbone diagram, because the analysis and error handling solutions are completely derived from the subjective consciousness of the user, the system allows the user to enter this information in addition to parameters which are automatically reported on fault stages, error types and related statistics.

Some typical visual reports of the software are shown with Figures 6, 7, 8, 9, 10 and 11.

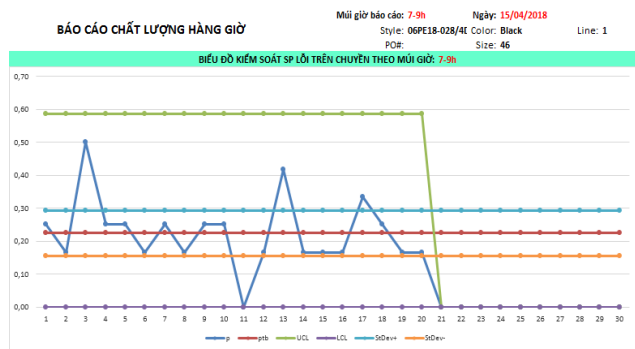


Figure 6. Control Chart

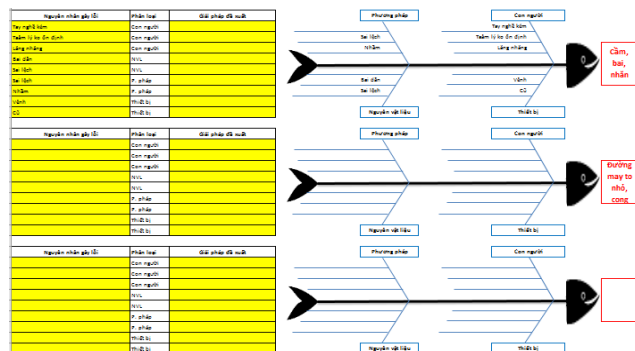


Figure 7. Fishbone Chart

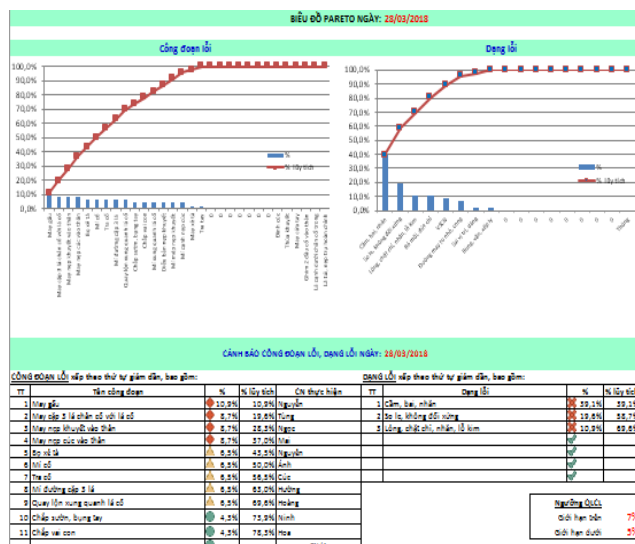
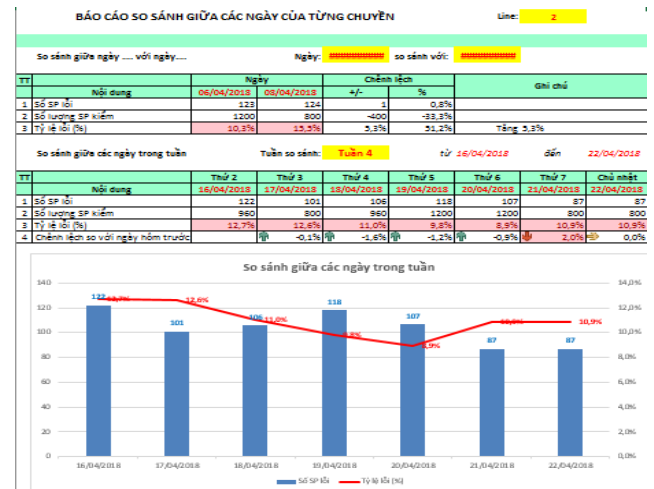


Figure 8. Pareto Chart Figure



9. Comparison chart of 1 production line

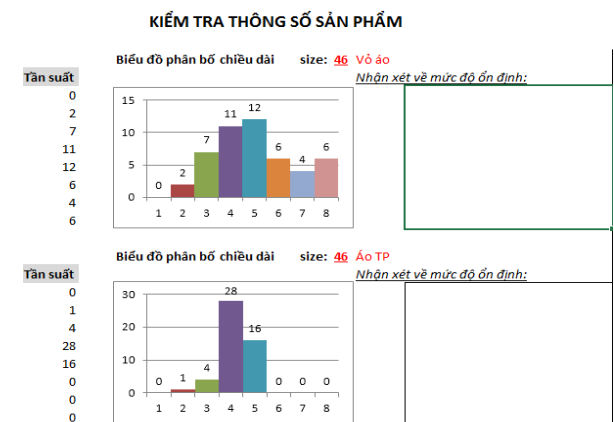


Figure 10. Chart for checking parameters

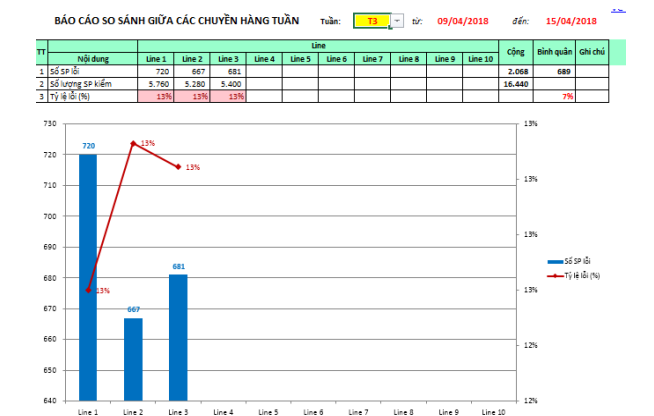


Figure 11. Comparison chart between production lines

Source: screenshot of garment line quality control system

The garment line quality control system is designed to run on MS Excel, so the product can be used immediately without having to install it. The system is optimized for parameters, so the file size is small, the information processing speed is

fast, and the report retrieval speed is extremely impressive compared to the huge data scale and the number of reports with many complicated images.

6. RESULTS OF EXPERIMENTAL RESULTS OF STATISTICAL TOOL APPLICATION SOFTWARE IN QUALITY CONTROL ON INDUSTRIAL GARMENT LINE

The software that applies statistical tools in quality control at MS Excel-based garment lines, after being built, is sent to the factory to run experiments, learn from experience and adjust some parameters accordingly when deployed on a mass scale.

The results show that the enterprises all evaluated the system of quality control reports as very appropriate and necessary for the process of managing and monitoring the product quality situation on the garment line; good support for the operation and quality control at factories.

6.1. For in-line QC module

Time zone reports help quality managers grasp the quality situation of each line, identify arising problems, arising points, arising causes for timely handling and improvement decisions. In order to fix the error phenomenon as soon as it is detected. Good quality control in each time zone will help stabilize the quality of the production line, increase production efficiency, and contribute positively to improving labor productivity and reducing waste in costs. Time, effort, money for repairing defective goods. The time zone check point is the core point of the production process, if the quality is controlled according to each time zone, it will be the basis for stabilizing the quality daily, weekly, monthly and of the whole code.

6.2. For end-line QC module

If the quality control process is strictly controlled, the end-line inspection will be performed more quickly and effectively. At the same time, without wasting repair work for the relevant parts, the quality control at this time is only for the purpose of controlling remaining errors in process inspection. Remaining defects are often in the final assembly parts of the product manufacturing process. However, the inspection at this location must still be carried out 100% of the number of products on the line, to make sure that the products before being warehoused must meet the

standards, there are no errors before packing the box. In fact, in the majority of enterprises, the quality control of the process is not strictly controlled, the quality control inspection is often pushed to the end of the implementation line. Therefore, the number of defective products at the end-line inspection point is still very high, causing waste to have to repair goods and reducing production efficiency. This is an important check point that determines the reputation of the enterprise.

With end-line inspection scores, quality reports mainly show the results of quality comparisons between days, weeks, and months in a line; between lines in a day, week, month etc. Through that, managers can evaluate the effectiveness of production days and production teams in the factory to have directions and orientations to strive for the implementation of next missions. With these reports, it will be easy in the production process, contributing to improving production efficiency.

Thus, with the system of automatic quality reports shown through the charts of the statistical tools, it will help managers easily see the arising quality problems without having to waste time for searching, sorting, comparing, selecting.

The most important point for quality control with applying statistical tools on the basis of information technology requires enterprises to strictly manage data collection in accordance with procedures and forms; collected data must be accurate, complete and regular; Data entry must be performed continuously according to the time zone for the on-line checkpoint, day by day for the end-line check point. Only then, the new management department can grasp how the quality of the system is going, so that there can be timely and appropriate directions; The quality reporting system with application of statistical tools then can promote its effectiveness to the fullest extent.

In order to process and improve the results of the quality control system effectively, it is required that experts have quick, timely and effective solutions. That requires a close combination of specialized departments involved in the manufacturing process.

7. CONCLUSIONS

In the current period of strong international economic integration, if garment enterprises want to compete and develop sustainably, they must improve their quality and labor productivity. One of the solutions that need to change drastically is to quickly apply information technology and modern statistical tools to the quality management work at the garment lines.

Garment line management software with applying statistical tools is designed to run on MS Excel, which does not require installment and can be used immediately as a regular Excel file. At the same time, the system is optimized for parameters, so the file size is small, the information processing speed is fast, and the report retrieval speed is extremely impressive compared to the huge data scale and the number of reports with many, complex images.

Phase 2 of the project, the research team will develop this software by programming running on the cloud computing platform. At that time, quality control staff on the lines enter error information in real time, the software will summarize on the server and issue reports as required. Users can view all types of reports or comparisons anywhere, anytime and on any internet-connected electronic device. At the same time, RFID technology will be integrated into the system to synchronously manage both productivity and quality issues at the garment lines.

This is a scientific product with creativity and high applicability, a useful tool to help the quality management at garment lines become simpler and more effective. People in charge of quality control will spend a lot of time on expertise instead of struggling to synthesize data, present tables, drawings etc. This software is developed by lecturers of Hanoi Industrial Textile Garment University with low cost but high efficiency; The quality reports that the system gives are extremely useful and valuable to those who work in quality control at the industrial garment line. Textile enterprises are highly suggested to quickly learn and equip this tool for themselves.

REFERENCES

- [1] Tran Thanh Huong (2008), Textbook of Apparel Quality Control, Ho Chi Minh City National University Publishing House.
- [2] Hoang Xuan Hiep and co-authors (2018), Textbook of Quality Control in Industrial Garment Enterprises, Hanoi University of Textile Industry.
- [3] Ngo Thi Thanh Mai and research team (2018), "Research and application of some statistical tools in quality control in industrial garment enterprises of Vietnam National Textile and Garment Group", Scientific research project report, Vietnam National Textile and Garment Group.
- [4] Nguyen Dinh Phan, Dang Ngoc Su (2013), Textbook of quality control, National Economics University Publishing House, Hanoi.
- [5] Vietnam Japan Quality Consulting Company (2017), Application of 7 statistical tools in production.