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Efficiency Losses of a Modern Loom with Analytical Explanation

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Original Research Article

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Abstract: In this study, the authors were carried out to find out some parameters that strongly effect on loom efficiency of Air-jet and Rapier loom and also find some possible solution to increases loom efficiency. Here loom efficiency affected by parameters as weaver's skill, loom speed, weave structure, pick density and R.H%, loom allocation per weaver, size take up %, tension on warp etc. Fabric quality, as well as production, depends not only preparatory process such as winding, warping & sizing, also depends on loom shed efficiency. A large proportion of weaving cost has found during conversion of yarn to fabric. Its shown that about 60% to 70% cost during conversion of yarn to the fabric can be minimized by using the modern preparatory machine and loom as rapier, projectile & jet. A small portion of increasing loom efficiency increase production and decrease total cost of production. Increasing loom efficiency also reduces wastage found in the weaving mills.
Keywords: Rapier loom, Air jet loom, Warp tension, Weave type, Loom speed, Size takes up %, Loom allocation.

INTRODUCTION

Every manufacturing industry is always emphasized to increase production with maintain product quality and it's always try to meet demands of both national and international customers by providing quality product in terms of cost [1]. Textile industry is world second largest industry. But every textile industry facing a problem of increasing productivity with maintains product quality.

A common barrier that does can reduce production in the weaving industry is warp & weft breakage. A large number of textile industry produce same types of yarn and fabric. So it is much challenging to meet consumer demands with lower cost. But cost depends on amount of fabric production [4]. Efficiency depends on the amount of time lost due to loom stoppages. Less the production loss due to loom stoppages more is the efficiency. In general, the factors on which production depends are also responsible for the efficiency. Efficiency can be classified into running efficiency, overall efficiency & shed efficiency. It takes into account the looms stopped say, for want of warps suitable for them for a week or so or for other causes, say for a day or two or more. Efficiency losses of loom are so much critical issues in the textile industry, specially weaving industry [2]. Efficiency is calculated for every shift according to production that's measured by actual production in meter [3]. Three major factors that are affected on weaving loom efficiency. These are technical factors (related machine setting and condition), human factors (related worker's skill, motivation and working methods) and organizational factors (related design and implementation of production plan). The reasons for efficiency losses in looms can be divided into two types as frequency dependent and miscellaneous. Warp and weft breaks, beam gaiting are the first category on the other hand healds broken, doffing, loom repairs, weave faults, etc. are termed as miscellaneous causes. Another cause of stoppage is interference.

Aim of the Study

To increase the loom production by finding the causes of efficiency loss during the production keeping accepted quality with better performance.

Objectives of the Study

- Investigation of causes of efficiency loss.
- Application of the analyzed result in convenient way.
- Introduce new method of improving the production rate of weaving loom.

EXPERIMENTAL MATERIALS & METHODS

Loom specifications

Rapier Loom:

No. of looms used	: 20
Weft insertion type	: Rapier
Loom type	: Flexible rapier
Loom maker	: Picanol
Loom model	: Optimax i
Loom speed	: 450-575 RPM
Reed width	: 66"-67"
Reed space	: 64"-65"
Weft Selection	: 8 colors pick with programmable microprocessor.
Shed Formation	: Electronic dobby (STAUBLI).
Weft Stop Motion	: Electronic 8-hole weft slide sensor.
Warp Detection	: Electric dropper pin type with 6 rows.
Let-Off	: Electronic let-off system ensuring uniform warp Beam tension.
Take Up system	: Electronically controlled.

Air-jet Loom

No of loom used	: 25
Weft insertion type	: Air
Loom type	: Air-jet
Loom maker	: Picanol
Loom Model	: Omni Plus 800
Total Heald frame capacity	: 12
RPM	: 500 to 950
Weft selection	: 6 Color
Weave type	: Plain, Twill, and Satin.
Count of yarn	: 16 Ne, 20 Ne, 40Ne and 50 Ne combed yarn.

Method

Loom efficiency can be measured by the following formulae:

$$\text{Loom Efficiency } (\%) = \frac{\text{Actual Production}}{\text{Calculated Production}} \text{ x } 100$$

The efficiency can be calculated quickly and expeditiously from computers. The use of computers enables the parameters to be continuously assessed so that better accuracy can be obtained [2].

After calibration of the computer software along with the parameters efficiency was taken after one shift production.

RESULTS & DISCUSSIONS

Data Analysis for Rapier Loom

Analysis of Efficiency by Speed

Experiment No: 1

Construction: 40x40/110x74; Weave type: Plain

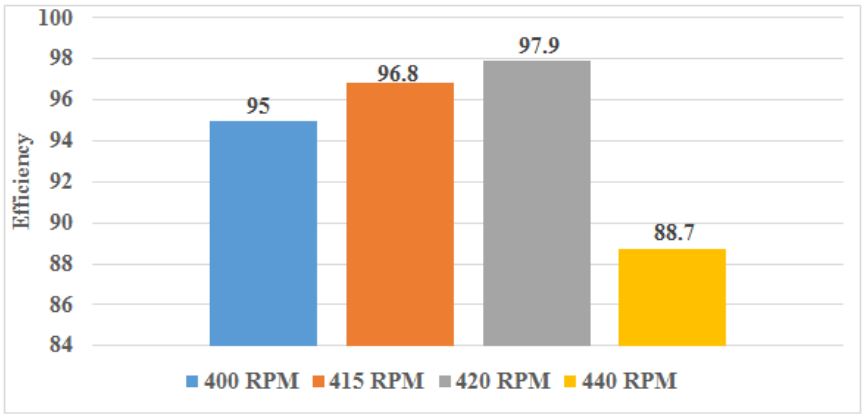

Fig-1: Analysis of Efficiency by Speed

Experiment No: 2
Construction : 40x40/120x80; Weave type : Plain

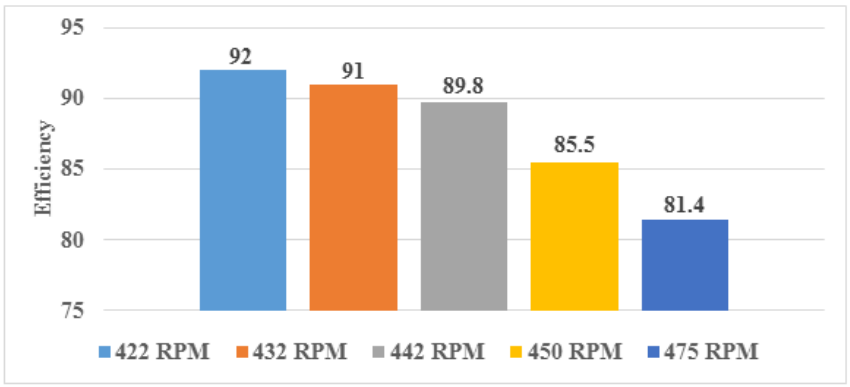

Fig-2: Analysis of Efficiency by Speed

Experiment No: 3
Construction : 40x40/130x90; Weave type : Plain

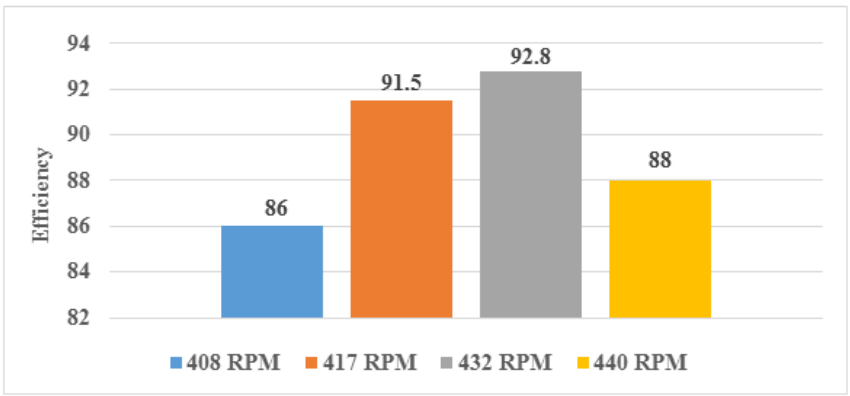

Fig-3: Analysis of Efficiency by Speed

Experiment No: 4
Construction : 50x50/144x76; Weave type : Plain

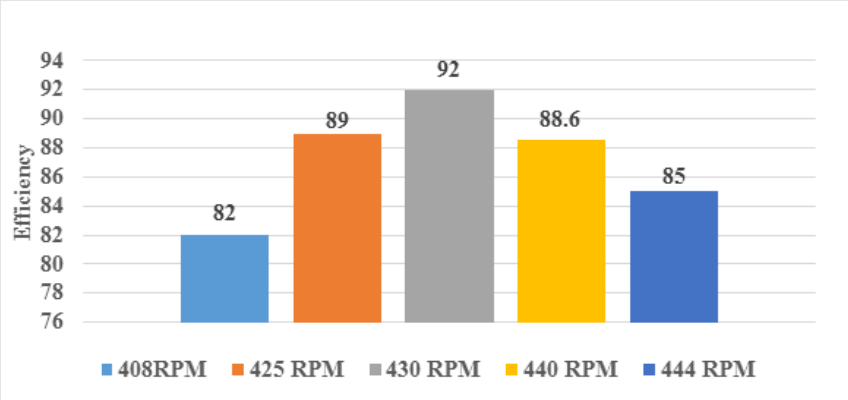

Fig-4: Analysis of Efficiency by Speed

From the above table it is found whenever there is higher loom speed it leads to higher end breakages. This will reduce the efficiency. But when we run a look at lower speed then the productivity decreases. Higher production also plays an important role in the industries improvement. So it is recommended to run the looms at optimum speed

Warp Tension Vs Efficiency

Experiment No: 1
Construction: 40x40/110x74; Weave type: Plain

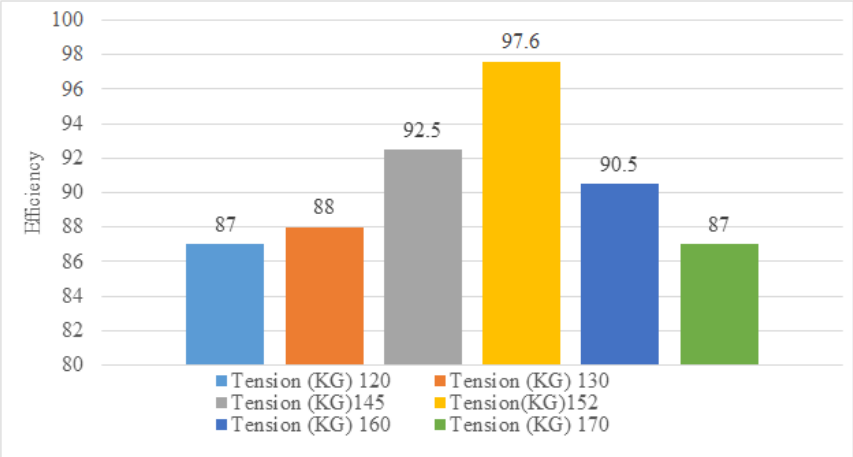

Fig-5: Warp Tension Vs Efficiency

Experiment No: 2
Construction: 40x40/130x90; Weave type : Twill (2/2)

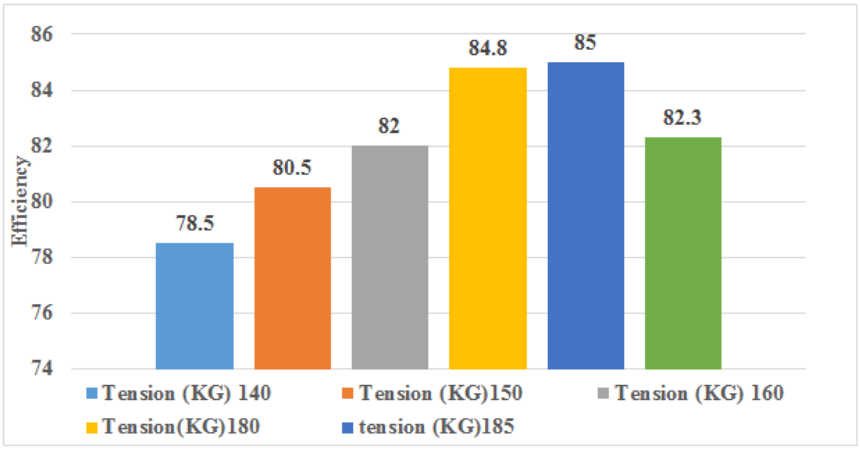

Fig-6: Warp Tension Vs Efficiency

More tension on warp yarn causes more breakage, but low tension makes the yarn entangled with each other. So, appropriate tension should be applied to get better quality fabric and optimum efficiency.

Weave Type Vs Efficiency

Experiment No: 1
Construction: 40x40/110x74; Loom RPM: 420

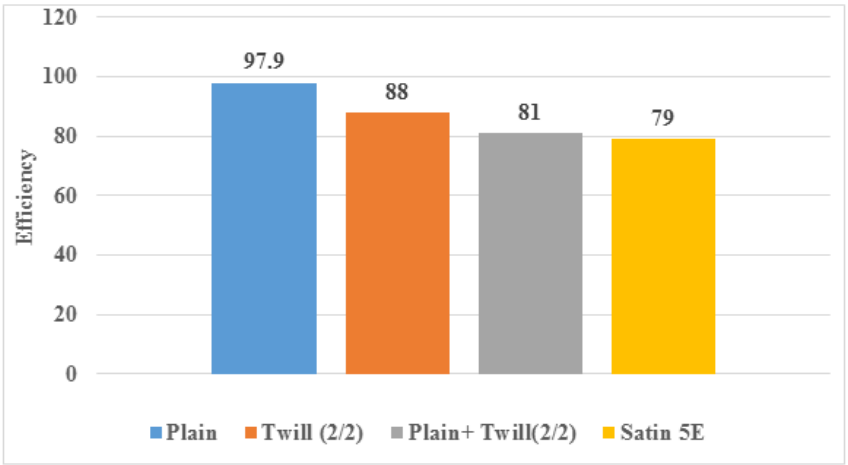

Fig-7: Weave Type Vs Efficiency

Experiment No: 2
Construction : 40x40/120x80; Loom RPM : 430

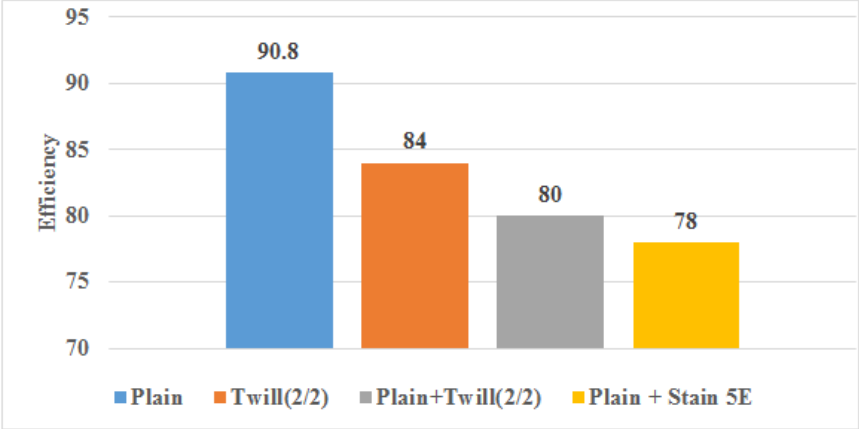

Fig-8: Weave Type Vs Efficiency

Experiment No: 3
Construction: 40x40/130x90; Loom RPM: 430

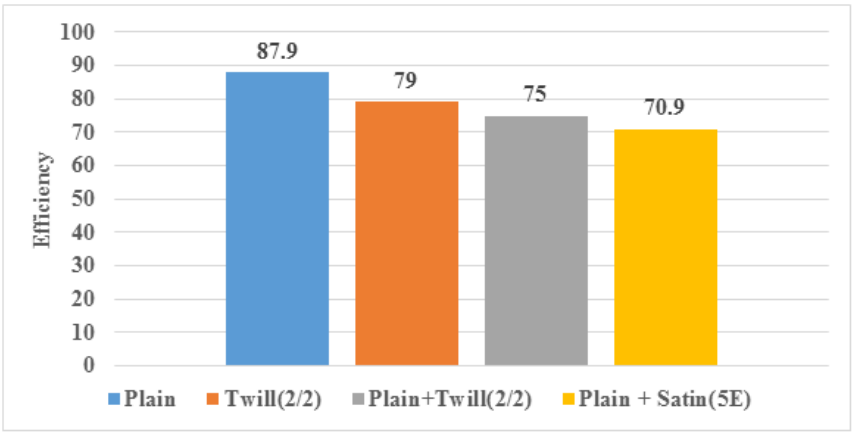

Fig-9: Weave Type Vs Efficiency

Since a fabric with high number of interlacing in the design or a high end density (EPI) and pick density (PPI) tends to have a large number of breaks. Plain weave gives the highest efficiency than other weaves for a particular condition. For complex design warp breaks more because of uneven tension on warp yarn. The more critical design the weaver takes more time for repair the warp breaks because of different sort of drawing. So, for complex design efficiency becomes low.

Analysis of Efficiency by Weavers
Experiment No: 1

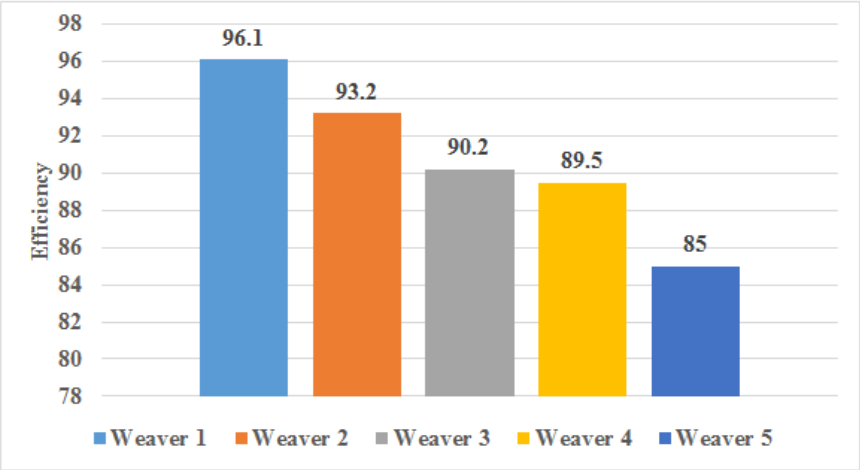

Fig-10: Analysis of Efficiency by Weavers

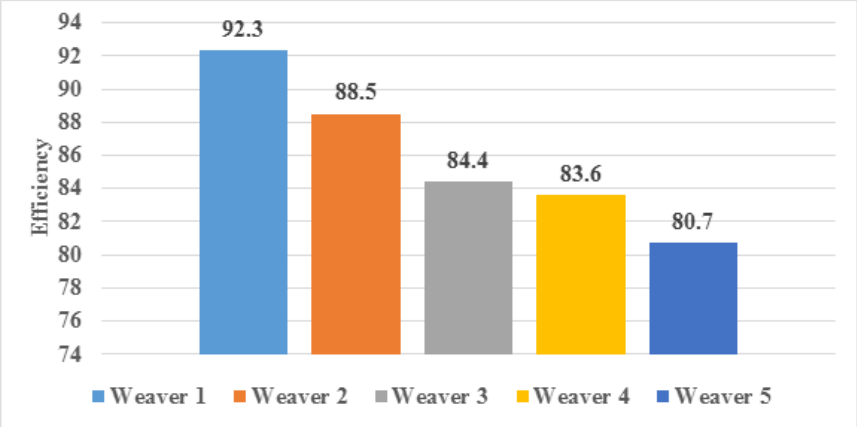

Fig-11: Weave Type Vs Efficiency

Experiment No: 2

Many reasons contribute to the lower weaver's efficiency. If one of the allocated loom stops and at the same time another allocated loom also stops then the weaver cannot able to attend both. This will decrease the loom efficiency, to reduce this, labor cooperation is needed. That is the weaver who is idle can attend the other loom[5]. Other causes are, if a multiple breakage occurs and at the same time another allocated loom stops, then the weaver should first attend the loom which can be restarted first. By doing this the idle time of one of the loom is reduced and efficiency is increased. The other causes following the inefficient weavers and talking with neighbors.

Analysis of Efficiency by Loom Allocation

Experiment No: 1

Weave type: Plain

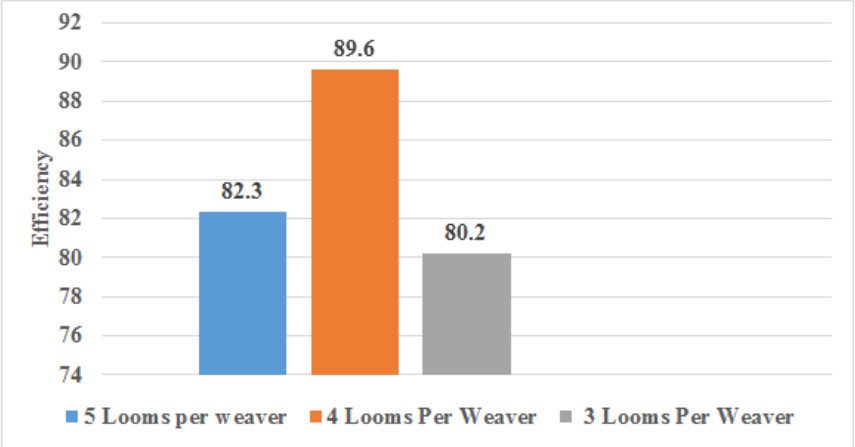

Fig-12: Analysis of Efficiency by Loom Allocation

Experiment No: 2

Weave type: Miscellaneous (Plain, Twill, Plain+twill, Plain+satin)

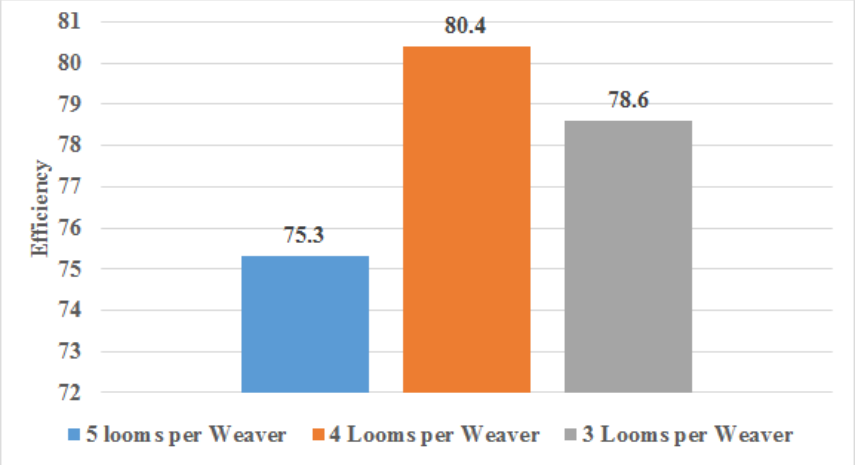

Fig-13: Analysis of Efficiency by Loom Allocation

This above chart shows that when lower looms are allocated the efficiency drops and when more looms are allocated the efficiency increases. While analyzing the reason this is because of the labors mischievous behaviors. When there are more labors in a place it will lead them to be more talkative and thus not attending the looms properly. To recover from this type of lower efficiency it is better recommended to keep a supervisor.

Size Take- up% Vs Efficiency

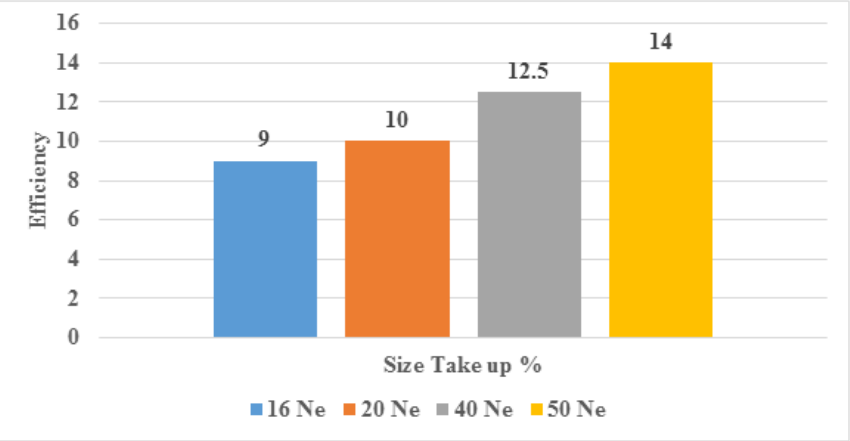

Fig-15: Size Take-up % Vs Efficiency

Experiment No: 1

For better performance following size take up % should be maintained. For a particular count, if size take-up % is more than required amount, than yarn becomes sticky and friction occurs more between yarn to yarn and yarn to reed. Problem also arises when knot passes into the reed[6]. Again if size take up % is less than required amount than yarn becomes weak, can't tolerate much stretch during weaving, hairiness causes entangled with each other. So, it is recommended for better performance of weaving appropriate size take up should be maintained strictly.

Data Analysis for Air-Jet Loom
Analysis of Efficiency by Speed
Experiment No: 1
Construction: 40x40/80x60; Weave type: Plain

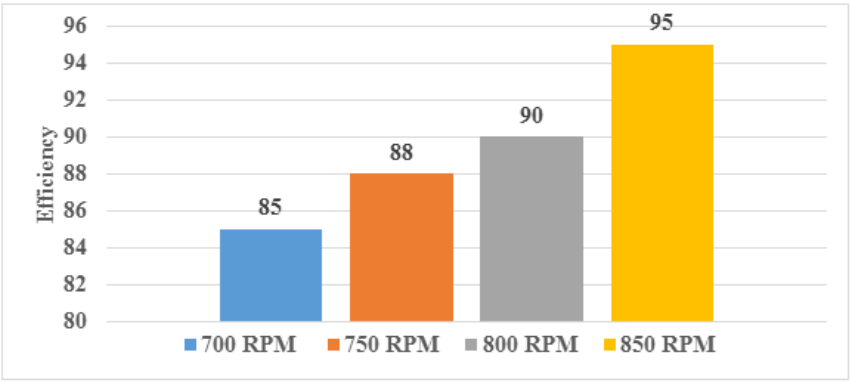

Fig-16: Analysis of Efficiency by Speed

Experiment No: 2
Construction: 40x40/140x70 Weave type: Plain

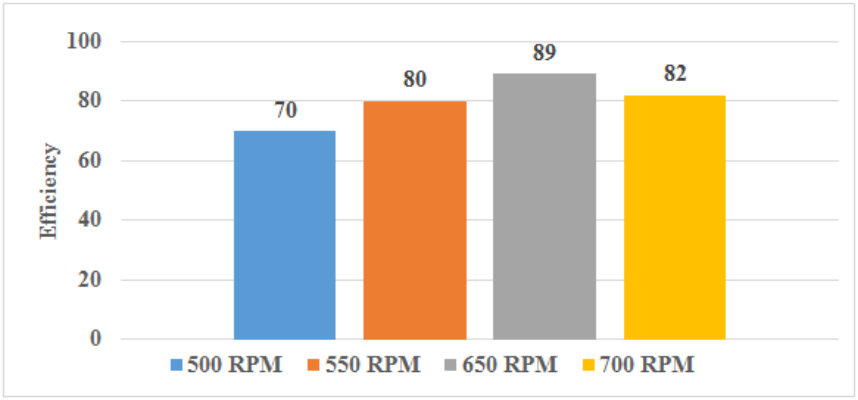

Fig-17: Analysis of Efficiency by Speed

Experiment No: 3
Construction: 60x60/154x114; Weave type: Plain

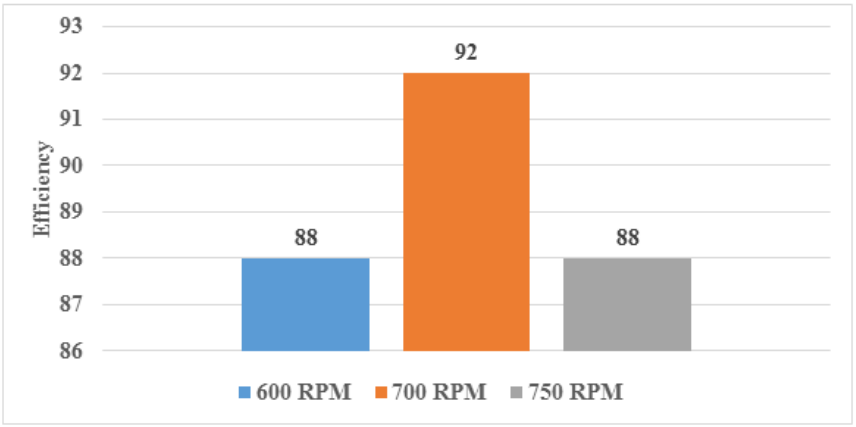

Fig-18: Analysis of Efficiency by Speed

Experiment No: 4
Construction: 20x16/128x60; Weave Type: Twill

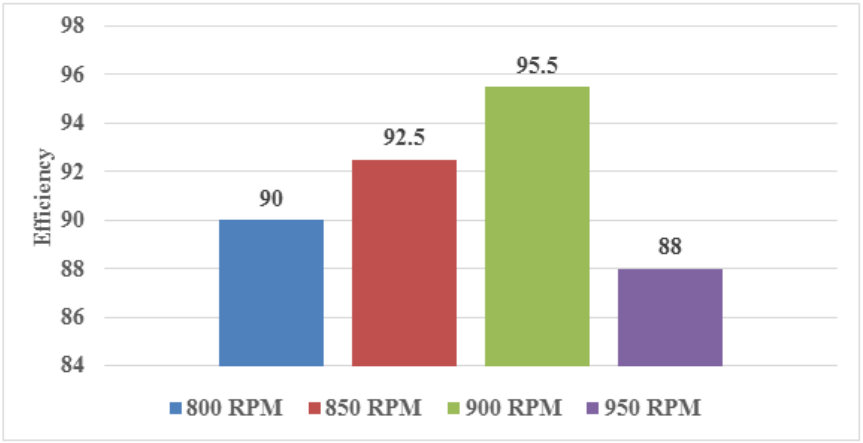

Fig-19: Analysis of Efficiency by Speed

From the above table it is found whenever there is higher loom speed it leads to higher end breakages. This will reduce the efficiency. But when we run a look at lower speed then the productivity decreases. Higher production also plays an important role in the industries improvement. So it is recommended to run the looms at optimum speed

Warp Tension Vs Efficiency

Experiment NO: 1
Construction: 40x40/80x60; Weave Type: Plain; RPM: 750

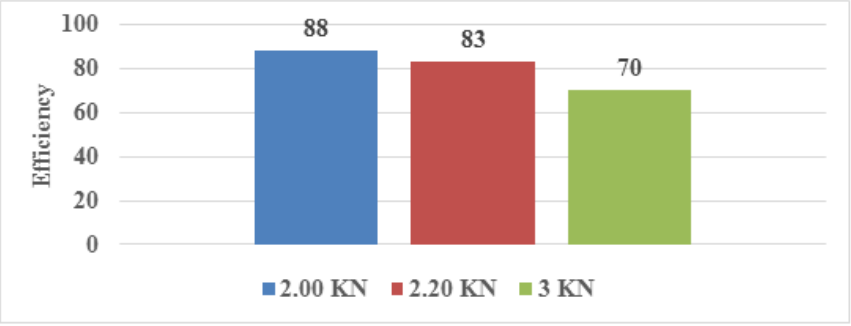

Fig-20: Warp Tension Vs Efficiency

Experiment NO: 2
Construction: 20x16/128x60; Weave Type: Twill; R P.M: 850

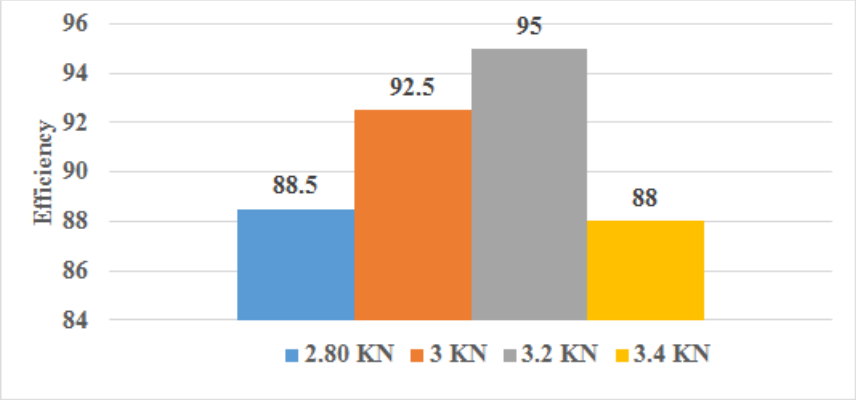

Fig-21: Warp Tension Vs Efficiency

More tension on warp yarn causes more breakage, but low tension makes the yarn entangled with each other. So, appropriate tension should be applied to get better quality fabric and optimum efficiency.

Weave Type Vs Efficiency
Experiment NO: 1
RPM AVG: 750

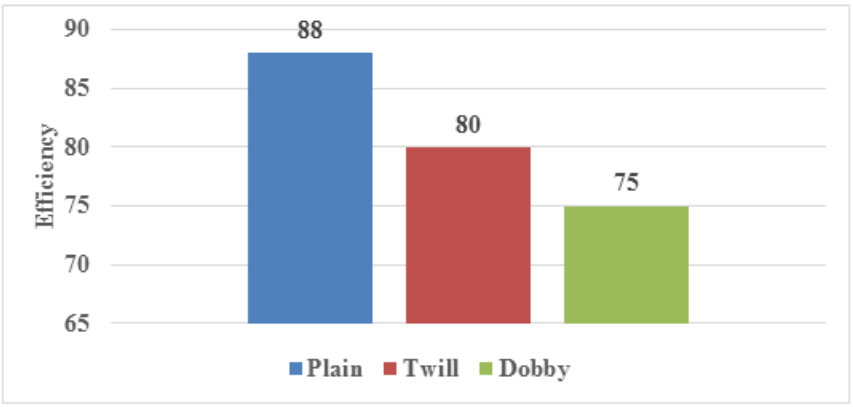

Fig-22: Weave Type Vs Efficiency

Since a fabric with high number of interlacing in the design or a high end density (EPI) and pick density (PPI) tends to have a large number of breaks. Plain weave gives the highest efficiency than other weaves for a particular condition. For complex design warp breaks more because of uneven tension on warp yarn. The more critical design the weaver takes more time for repair the warp breaks because of different sort of drawing. So, for complex design efficiency becomes low.

Shift VS Efficiency

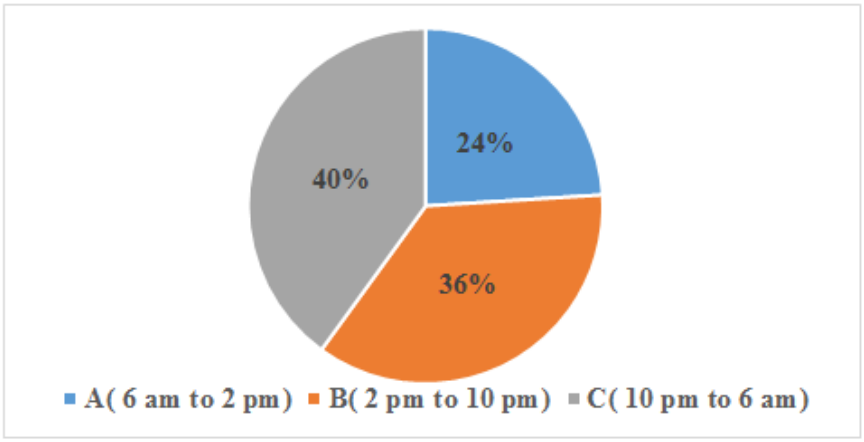

Fig-23: Shift VS Efficiency

Experiment NO: 1
Analysis of Efficiency by Weaver
Experiment NO: 1

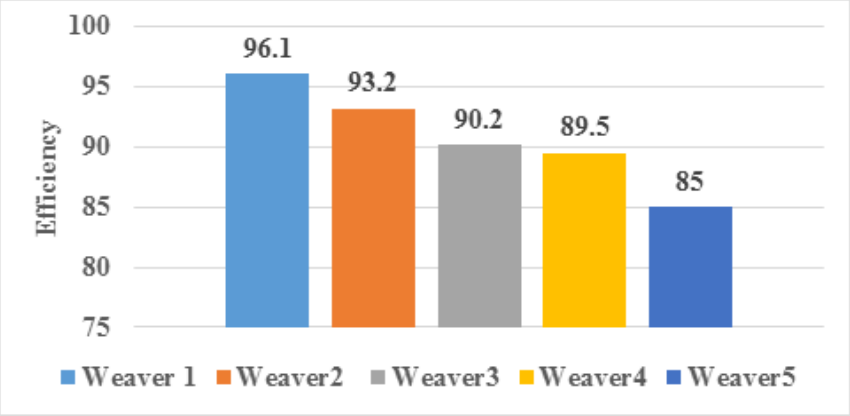

Fig-24: Analysis of Efficiency by Weaver

Since a fabric with high number of interlacing in the design or a high end density (EPI) and pick density (PPI) tends to have a large number of breaks. Plain weave gives the highest efficiency than other weaves for a particular condition. For complex design warp breaks more because of uneven tension on warp yarn. The more critical design the weaver takes more time for repair the warp breaks because of different sort of drawing. So, for complex design efficiency becomes low.

Analysis of Efficiency by Loom Allocation
Experiment NO: 1
For Plain Weave Structure

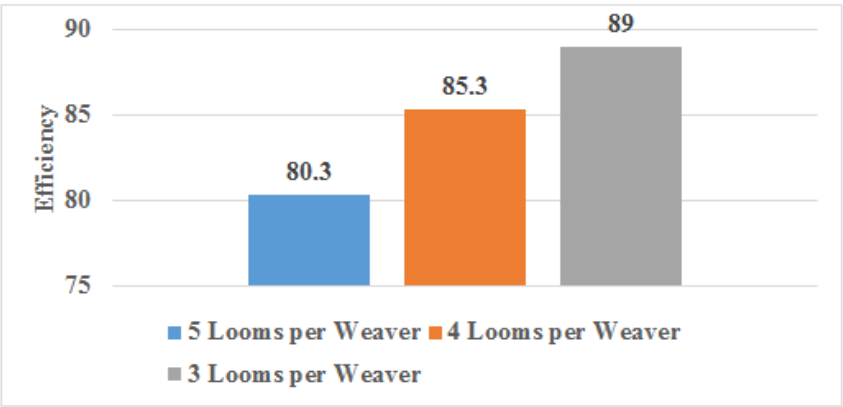

Fig-25: Analysis of Efficiency by Loom Allocation

Experiment NO: 2
For Plain + Twill Weave Structure

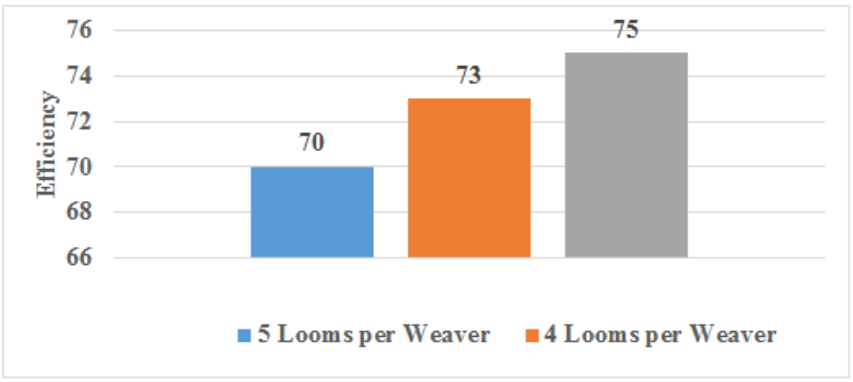

Fig-26: Analysis of Efficiency by Loom Allocation

This above chart shows that when lower looms are allocated the efficiency drops and when more looms are allocated the efficiency increases. While analyzing the reason this is because of the labors mischievous behaviors. When there are more labors in a place it will lead them to be more talkative and thus not attending the looms properly. To recover from this type of problem we should maintain proper monitoring and after this we gain proper efficiency.

Analysis of Size take- up% Vs Efficiency

Experiment no: 1

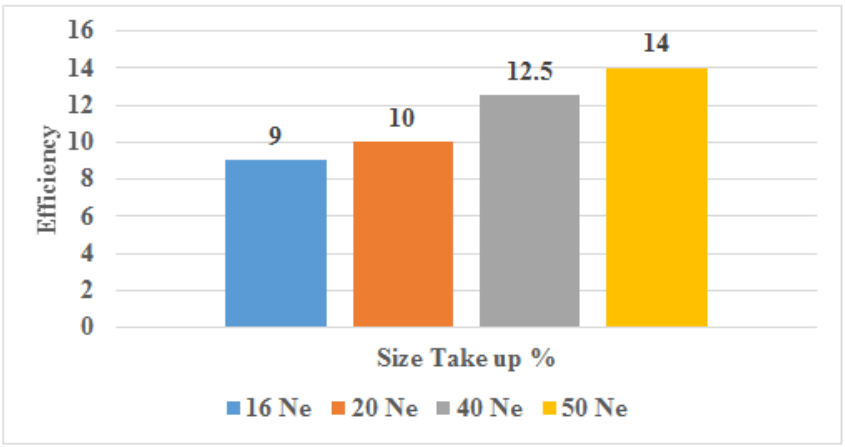

Fig-27: Analysis of Size take- up% Vs Efficiency

For better performance following size take up % should be maintained. For a particular count, if size take-up % is more than required amount, than yarn becomes sticky and friction occurs more between yarn to yarn and yarn to reed. Problem also arises when knot passes into the reed. Again if size take up % is less than required amount than yarn becomes weak, can't tolerate much stretch during weaving, hairiness causes entangled with each other. So, it is recommended for better performance of weaving appropriate size take up should be maintained strictly.

DISCUSSION

Various problems should be controlled and the stoppage rate should be low. The various stops can be divided in 4 classes

- Stops due to warp breaks and warp faults.
- Stops due to weft breaks.
- Stops due to mechanical failures.
- Miscellaneous stops.

Machine maintenance also plays an important role in the efficiency of the machine. Proper lubrication and cleaning should be done routine wise. The preventive maintenance is needed for better performance of the loom. A supervisor should be present for all eight hours of the shift. It will considerably increase the efficiency. It is also very useful if rotating cameras are fixed all around the loom shed so that supervision may maintain proper flow of production. It is proven that in mills where there is a consistently low warp breakage rate, the yarn CSP is higher and less defected yarn in production floor. A weak, fuzzy yarn will break very often whereas a strong smooth uniform yarn will withstand the weaving conditions better. When there is poor raw material, then the efficiency of the loom as well as the quality of the fabric decreases. Sizing plays a vital role on efficiency. So appropriate size take up should be followed by manger strictly[5].

Skilled weavers can repair broken yarns very quickly compared to unskilled weavers. Also the work load of the weaver has a very important effect on the weaving efficiency, since it affects the time a loom is stopped awaiting attendance. The weaver should be trained so that he takes the minimum possible time for clearing a stop. Loom allocation should be as per as the skill of the operator.

The weaver's room atmosphere plays an important role in loom efficiency. Whenever there is a change in these two parameters then there will be a chance for drop in the efficiency Motivation is another major thing to be considered. If a weaver is able to produce higher efficiency, he should be encouraged by higher percentage of wages or in some other way. At the same time if a weaver produces lower efficiency he should be punished by reducing the percentage of wage or by some other way [4].

CONCLUSION

The efficiency is analyzed by various parameters. In this study authors have found following results:

- RPM Vs Efficiency: Efficiency increases with RPM at a certain level, then start to decrease
- Warp tension Vs Efficiency: Efficiency increases with tension at calculated tension otherwise more tension causes warp breakage.
- Weave type Vs Efficiency: Mixing of different weave type causes efficiency loos.
- Loom allocation Vs Efficiency: More loom allocation with less skilled worker cause decrease of efficiency
- Size take up % Vs Efficiency: Proper size take up % maintain good efficiency

While taking corrective action from the results analyzed, authors can get a higher efficiency. A small increase in efficiency will give higher productivity and profitability and that has been obtained. From the results the various factors affecting the efficiency is found and by concentrating in those areas the efficiency of the loom shed is increased.

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