REVIEW OF 3 STRATEGIES TO IMPROVE PROFITABILITY OF SMALL SAWMILL OPERATIONS

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Second Reader

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ABSTRACT

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Keywords: business, lumber, profit, revenue, sawmill, strategy

Sawmills can be an attractive business opportunity. Their low cost of purchase and maintenance, combined with the incredible variety of things which can be produced provide great potential. However, it can be easy to underestimate some of the difficulties which will be encountered. This review focuses on 3 areas where a sawmill business can improve its profitability. These are to increase throughput of the sawmill, areas to decrease cost, and focusing on value-added products. Several strategies were reviewed with the most potential being found in value-added products.

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Introduction

Sawmills can be an attractive business opportunity due to their low cost to start up and potential markets. Small business owners typically face a choice of either purchasing a horizontal bandsaw mill or circular sawmill. Horizontal bandsaw mills are inexpensive to purchase while providing a large amount of flexibility in sawing operations. There are many manufacturers, helping to keep prices competitive. Circular mills are available in several different options. Old fashioned examples are more affordable, but are dangerous, inefficient, and wasteful. Newer models are much more portable, use a thinner blade, and can produce lumber even more accurate than band sawmills. Modern bandsaw mills are preferred to older, wide blade circle mills (Kambugu et al. 2005). The various types will be introduced in the literature review.

This low price provides an easier entry than a manufacturing line or harvesting company. They appear simple to operate and produce a commonly used product. However, profit margins can be thin, and it can be very difficult to compete against larger operations. Scaling up can be a tempting method to reduce cost (Roos et al. 2001), but it is usually advantageous to focus on a smaller market with higher value products before expanding. This thesis will look at 3 options to increase revenue of a small sawmill operation, or SME (a business having less than 50 employees) (Liberto, 2023).

These are to increase throughput of the sawmill, reducing cost of the finished product, and focusing on value-added products. A value-added product is defined as a product with an increased value due to secondary processing, compared to the original

(Merrium Webster 2024). Primary processing produces commodity lumber in comparison.

Some other definitions to note, a board foot is a square of wood 12 inches by 12 inches by 1 inch. Recovery means what percentage of the log was turned into lumber. Production is measured in board feet per hour (Wood-Mizer 2024a).

There have been many technological improvements in the tools needed to produce sawn wood products. From the invention of the bandsaw mill in the 1800's to modern computer-controlled saws, there have been massive improvements in production, safety, accuracy, and quality of the finished product. There is a trickle-down effect to smaller, more affordable equipment. Some of these include hydraulic assist on controls, computer assist on the saw head, and better blade technology (Siklienka et al. 2015; Wood-Mizer 2023). Modern statistical tools let anyone analyse their business. Research indicates that economies of scale result in cheaper output until a daily production of 30,000 board feet is reached (Puttock and Prescott 1992). This is far outside many small mill abilities, and indicates that investment in production is likely to be worthwhile (Nyrud and Bergseng 2002). A typical small portable mill may only produce 5,000 bdft per day.

Producing value-added products allows a business to produce more revenue from the same input. Value-added products often have higher margins, and these companies are better positioned to invest in new technology (Roos et al. 2001). Examples of value-added products from a portable milling operation include siding, shingles and shakes, and 6 sided posts, to name a few. Other value-added products

can be made however this requires other equipment, such as a Kiln or a molder to make tongue and grove flooring.

New markets can also be accessed, providing new opportunities to the same equipment. This could be producing larger timbers, completing rush jobs which can otherwise not be fulfilled, or producing heavy decking lumber for shipping industries. Essentially, niche markets are areas of high potential due to larger mills not being able to adjust to specialty requests.

The literature review below provides some insight into the 3 areas regarding methods to improve revenue and profit. Value-added and high value products offer the greatest opportunity, while the other two options should be treated as supporting objectives. It will provide insight especially for the reader who already has some experience with a sawmill and is looking for data driven information to improve his operation.

OBJECTIVE

Owners of small sawmills are often unaware of any research related to their business. Many of the problems they work to solve have already been answered. This review will provide some insight into the literature currently available, especially regarding methods to improve profit. Various areas such as reducing costs, improving efficiency of the business, and finding ways to add value to product were looked at. This paper will provide some direction for new and experienced operators regarding methods of improving profit and viability of their business.

MATERIALS AND METHODS

There is a vast body of research regarding the sawmill industry. To provide some focus the literature was primarily focused on (1) methods to improve efficiency, (2) methods to increase production, and (3) value-added products. This paper utilises primary sources including technical manuals, academic journals, government publications, and industry publications. These sources were accessed primarily through google scholar.

Literature Review

The 3 primary methods of increasing profit are to increase throughput, to reduce cost, and to focus on high value/value-added products. These strategies can be combined, and the following literature review will highlight some key points in the literature.
A brief introduction to common sawmills is provided for reference.

Common Sawmill Options

Band Saw Mills

Band saw mills use a metal band with teeth which is fastened into a loop. In this way the loop can be made to any size to cut any size of log (Kambugu et al 2005). The blade runs over two wheels which guide and support it. There may also be smaller guide wheels which provide more control to the blade at the entrance and exit of the blade in the wood. This can be seen in figure 2. Band saw mills are capable of

producing from less than 100 to over 675 bd feet per hour. These values are subjective, and depend on blade and sawyer performance, log size, and worker skill. These mills often use a gas engine of 8-70 horsepower and range in price from $3299.99 to $106,490. Larger mills may use a diesel or electric motor. (Occeña et al. 2001). Blade kerf is typically .055 to .162 of an inch (Steele et al. 1992; Siklienka et al. 2015).

Figure 1: Wood-Mizer Band Saw Mill (Wood-Mizer 2024)

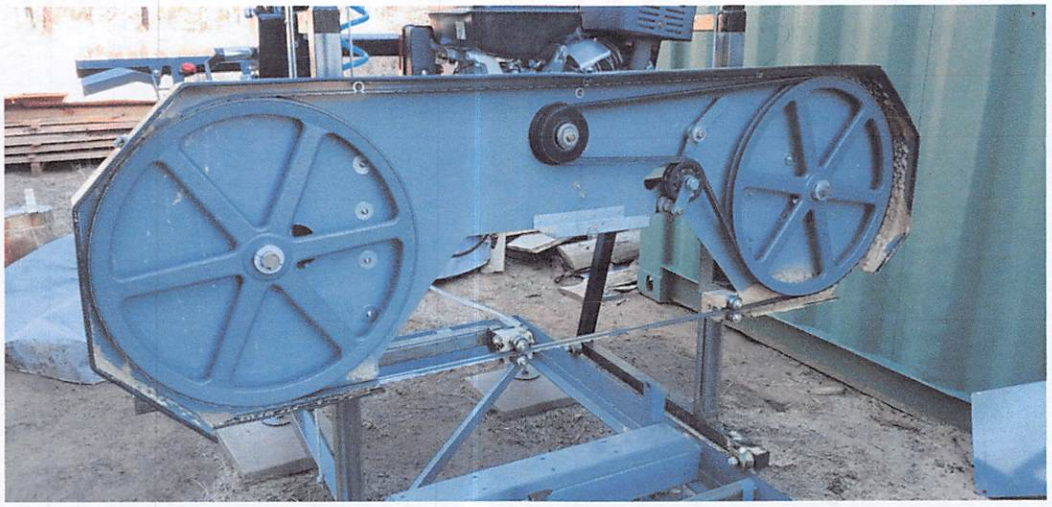


Figure 2: Closeup of Band Saw Mill

Circular Blade Sawmill

A circular blade sawmill uses a large metal disk with teeth fixed along its outside edge. The blade spins and logs are typically fed into it. This type of mill can produce more accurate lumber than a bandsaw mill, although there is a larger kerf and more waste associated with this. These blades are more easily sharpened and often have replaceable teeth. A circular saw may see an accuracy of 1.5 mm compared to 4.5 mm for a bandsaw at a feed rate of 24 meters per minute. This mill can cut up to 500 bd ft per hour (Atanasov 2021). A circle saw blade may have a kerf of .282 of an inch or greater (Steele et al 1992).

Figure 1: General view of a circular saw machine *Kara Kallion Konepaja Oy* – Finland

Figure 3: Closeup of Circular Saw blade

Chain Saw Mill

Chainsaw mills are extremely portable, typically weighing less than 150 pounds. A complete mill can be purchased for under $3000 dollars ("ALASKAN® MILL BUNDLES" 2024.; "STIHL MS 880 | Gas Chainsaws" 2024). The chainsaw mill will have 10-14% less

recovery than a band saw mill (Cedamon et al. 2012). Actual production numbers are very difficult to find, and could not be located as of publishing. There is severe waste with this method due to the width of the cutting chain. The kerf is typically .35 inches, with another .2 of an inch left for finishing due to the rough surface finish left (Harrison and Herbohn 2001). Under similar conditions and with similar value machines a circular sawmill can be up to 8 times more productive with higher quality finished product (Atanasov 2021).

Figure 4: Chainsaw Mill (Granberg 2024)

Methods of increasing throughput

Increasing throughput of a sawmill can allow for more efficient use of resources such as electricity and labour. Methods of increasing throughput often revolve around faster, more efficient saws, as well as making better use of machine time.

Maness and Lin (1991) found that a sawmill can increase their recovery and output by focusing on removing more 1" product. However, they note that while revenue is increased, profit may not follow due to the low cost and quality of this 1" product, as well as the increased time required to produce it.

Optimizing for Certain Products

It is important when setting up and operating a sawmill to consider what the finished product will be. This will ultimately determine the size of logs needed. While a mill may produce many different products over the course of a day or week, choosing the right size logs can play a large role in the recovery rate and time efficiency. Logs which are too small will only produce a few boards of the desired width, while logs which are much larger will produce more waste and a missed opportunity for wider lumber. Wider lumber typically sells for a premium. Figure 1 displays how smaller logs may have a lower value ratio. Value ratio is the cost of the log and processing divided by the revenue from selling the lumber. If the lumber sold is worth less than the log and processing than there is a negative value ratio. Lin et al (2011) found that some logs may even be sawn at a loss, although the average value ratio is over the course of a day.

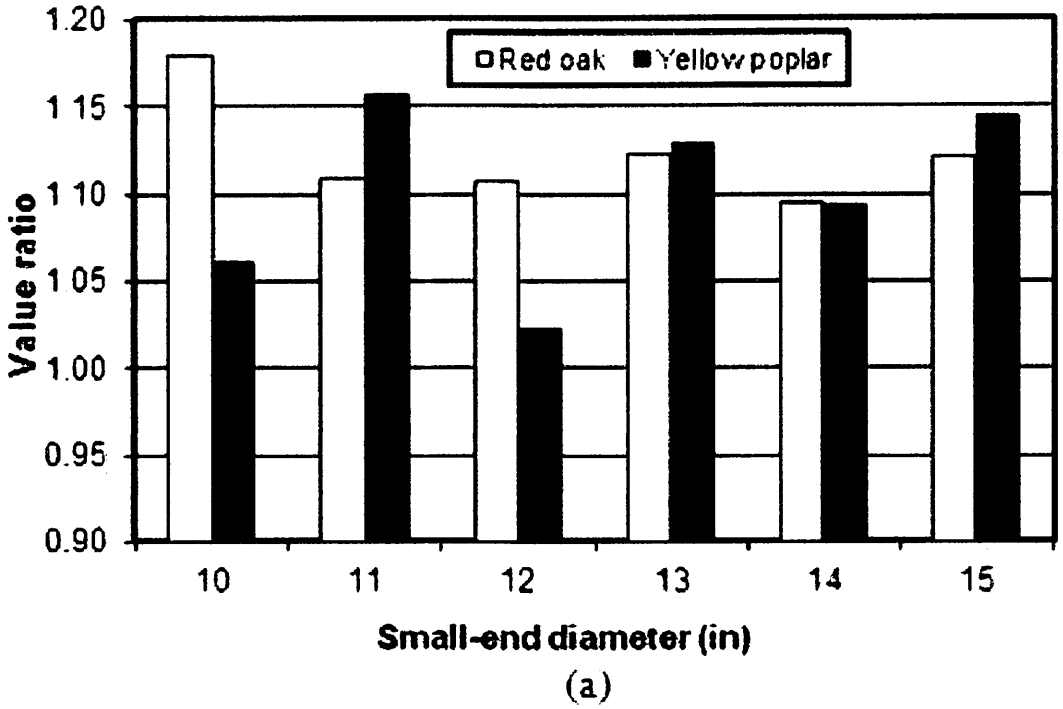


Figure 5: Log value Ratio by Diameter

Improving saw uptime has a direct correlation to improved throughput of a sawmill. It is often neglected and can be lower than expected (Borz et al. 2021). Actual time with the blade cutting wood can be as low as 29%. Other time is spent repositioning the workpiece, adjusting the saw height, adjusting the blade guides, and returning the saw head. Borz et al. (2021) found that this productive time still only accounts for 65% of the operating time. The remainder was spent in maintenance, repairs, reloading or cleaning the saw, and unexpected downtime. It can be very easy to waste time. It is critical to focus on uptime, to maximize throughput. Non-productive work should be combined where possible or done outside of productive hours. Log loading should be done at the same time as slab removal, or ideally continuously to

prevent shutdown. Greasing and fueling should be done on break or at the end of the day.

Things for the mill owner to be aware of which affect up and downtime can be unexpected. Blades can strike metal or wear faster than expected. New operators can require training and make mistakes. The sawmill may require adjusting when restarting after a break or for the first log in the morning. This can require a mill stoppage and may also produce unsellable lumber initially. For example, incorrect blade tension, frozen logs, or dull blades may all be encountered in the morning (CFI 2019).

Sawmills should adjust their feed speed to minimize energy costs when sawing. It is important to focus on energy used per wood cut, rather than per hour or per log. Bariska and Pásztory (2015) found that sawmills had potential for increased feed speeds and reduced power consumption. They found that a sawmill is at its optimum performance when the gullet of the tooth is filled as the tooth leaves the cut. Many sawyers do not cut at this optimum rate, and an improvement of 30% in cutting speed was found while reducing energy used to cut. Another point to note is that oak prefers a 40% faster feed rate than pine in this study, or 47.5 meters per second.

Gligoraş and Borz (2015) found that certain species can have a large effect on sawing speed and recovered volume. Oak had a mean recovery of 79%, compared to a 60% recovery rate in spruce. This can be attributed to various growth forms. The oak required 30% more time to saw, but when combined with the higher value this may be a better option.

Blade Performance

It is important to note that no blade will perform well in all species or under all conditions. Manufacture recommendations can be used to help develop a starting point for blade selection. However, it is up the operator to select the best blade for the application. Various testing methods can be used, but the most important part is to use repeatable conditions and to note the results. Some general guidelines are that a tooth set over .06mm in hardwoods can cause blade deflection, while too narrow can cause the same problem in softwoods (Blackwell and Stewart 2003). Wider blades can help maintain stability, although some mills may not be capable of tensioning these blades properly (Blackwell and Stewart 2003).

Lehmann (1985) found that most blade deflection could be predicted by the stiffness of the tooth tip. The greater the stiffness the more accurate the cut. The greatest factors affecting this were thickness of the blade, the blade tension, and the length of the blade unsupported by guides. Thicker and wider blades were found to be more stable, especially at higher tensions. Reducing the distance between the guides to the minimum practical also helps reduce deflection. Steele et al. (1992) found that for a band saw blade thickness difference of .023 inches there was only .02 board variance. The total sawing variation was also .02 between these two blade configurations. Blades were tested with a kerf of .055 inches and found to have an accuracy of 4 mm at 24 meters per minute feed (m/min) rate. However, when the feed rate was slowed to 6 m/min the accuracy increased to 1.5 mm.

Methods of decreasing production costs

Improving Blade Performance

Experimenting with blade choice can have significant impacts on the cost of the finished product. Maness and Lin (1995) look at the impact of reducing blade kerf or improving sawing accuracy. Switching to a thinner blade will allow for less log waste. However, they found that blade kerf has no effect when making cuts in the exterior of the log, as the kerf is taken from the slab rather than the board. For a saw which saws mostly beams or otherwise is involved in log breakdown, a thicker blade may increase board feet per hour without reducing log recovery.

Various band saw blade technologies are available which help deal with the many conditions faced. Wood-Mizer offers many options. Steeper hook angles are used for more aggressive cutting in soft, consistent wood. Angles of 7-11 degrees are common in clear pine. As wood becomes more knotty, frozen, dirty, or harder lower angles are used. This helps the blade to cut straight at the expense of speed and longevity. Frozen wood may use an angle of 2 degrees (Wood-Mizer 2023).

A thicker band material may be used to help improve stiffness, which helps reduce blade deflection (Lehmann 1985). Blade spine thickness range from .035-.055, with wider blades requiring motors over 24 horsepower (Wood-Mizer 2023).

Siklienka et al. (2015) found that better cutting performance and blade life can be achieved in frozen wood by careful blade selection. They compared swaged or hammered blade tips and blades with Stellite bonded to the cutting face. Stellite is a cobalt alloy which is very hard and wear resistant (Corrosionpedia 2019). The stellite

bonded teeth experienced double the useful cutting life, lasting for 4800 meters in frozen beech compared to 2400 meters for the swaged blade. The accuracy was also improved from .8 mm deviation to .6 mm deviation after 2000 meters of sawing. The stellite tips do require 1 kw more power to push through the wood, but this is offset by increased accuracy and longer life.

Reducing Waste

Thinner blades are particularly suited to small diameter logs. These are more common in plantation forests, and special equipment is recommended to maximize recovery from them. The reduced kerf of a bandsaw mill will boost recovery of these small logs. An increase of 14% was predicted while sawing logs 10-19 cm diameter, compared to a circle mill (Kambugu et al. 2005).

Improving the accuracy of the blade can also reduce waste by cutting closer to the desired finished size. By reducing blade variance, the cuts can be made closer to the actual finished board dimension. More precise blade guides, better computer setworks, and better saw filing are a few areas which can be focused on to reduce waste. Maness and Lin (1995) found a 2% revenue increase for every 0.01-inch reduction in target board size, and a 17-21% revenue increase when blade kerf was reduced by an $1/8^{th}$ inch (Mitchual et al. 2007). Blade deviation over 0.03 inches should be considered an alignment issue and addressed. Similarly, Lin et al. (2011) found that most mills saw 1/8 of an inch larger than the desired finished size. This is to account for drying shrinkage, warping, and sawing defect. However, the extra 1/8 of an inch results

in a 9.3% yield loss. While some of it is avoidable, minimizing this can significantly improve recovery.

Carino (1986) found an increase of up to $140 dollars per hour by improving the sawing accuracy and reducing waste. Primary areas focused on were reducing the trim length of logs. This can be done both when the log is first cut and when the log is re-trimmed at the mill. Some excess is necessary to allow for cracking and end defects in the log. However, this should be minimized. Reducing the time in between harvesting and sawing can allow for a reduction in trim length due to less drying. Carino (1986) also found that there is room for improvement in sawing accuracy. By improving this the target green size can be reduced, allowing for better recovery of each log.

Similarly, choosing a chainsaw mill can be attractive due to the low cost of entry. However, the lumber produced is likely to be more expensive due the lower output (Cedamon et al. 2012). Chainsaw milling was found to have about 13% lower recovery, largely due to a large kerf and a much rougher surface finish that will require planning so more oversize cutting to accommodate this.

This combined with the reduced output causes bandsaw milling to outperform.

Capital Investment

Nyrud and Bergseng (2002) found that an investment in capital does not always result in immediate efficiency changes. There were multiple cases where sawmills did not reach peak output until 3-5 years after an upgrade. This indicates that there is a knowledge gap which must be filled before the desired goals can be realized.

Improving Saw Patterns

It is important to note that a sawyer can have several different goals when deciding how to cut a log. The two most common choices are to maximize the volume of wood recovered from a log, and to maximize the value recovered. Low value products and those cut from low quality logs are more often focused on volume. Extracting more lumber from the same log will reduce the cost of the lumber, although time taken can be longer. There is less focus on the orientation of the log when cutting, especially because there may be too many log defects to avoid (Lin et al. 2011). A common method for this type of recovery is the flat sawn or through and through method.

Sawing for maximum value recovered focuses more on the grade or quality of the sawn board. This is much more common in high quality hardwood lumber. In this system the sawyer must be more careful in how the log is cut. The first cut, or opening cut determines how the rest of the log can be cut and is therefore crucial to get right (Lin et al. 2011). It is recommended that the opening face be marked with paint to aid the sawyer, reducing time spent positioning the log.

Quarter sawing can be used to recover more value from a log. In this method boards are cut so that the grain runs perpendicular to the width of the board. This is called a radial grain pattern.By doing this a board is less likely to cup or experience other drying defects. It will be more stable when created into furniture. Using a quarter saw pattern can yield up to 55% of a log with radial patterned lumber. However, other methods can produce more total volume and may be more valuable. Cant sawing

involves creating a square beam, or cant from a log and then sawing it top to bottom. This method, also called flat sawing, produced only 7% radial grained lumber. However, it had a total recovery of 84%. (Vilkovský et al. 2023)

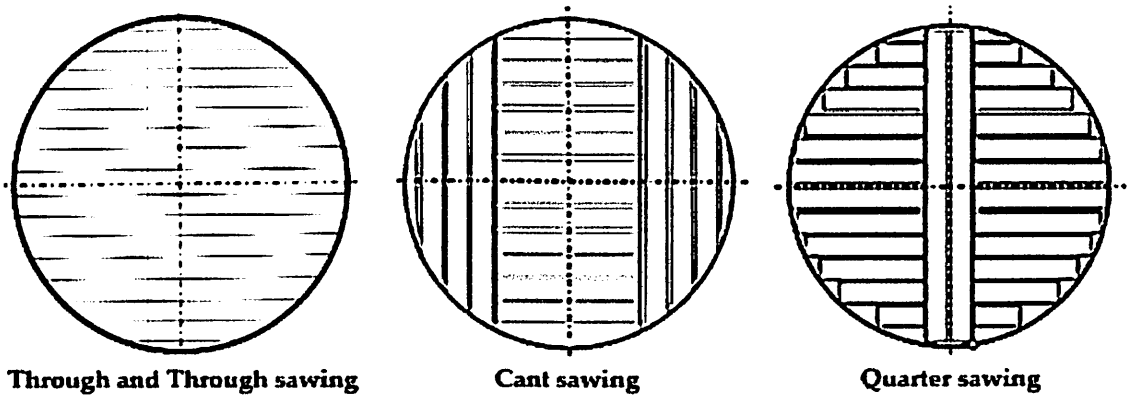


Figure 6: Selected sawing patterns (Vilkovsky et al. 2023)

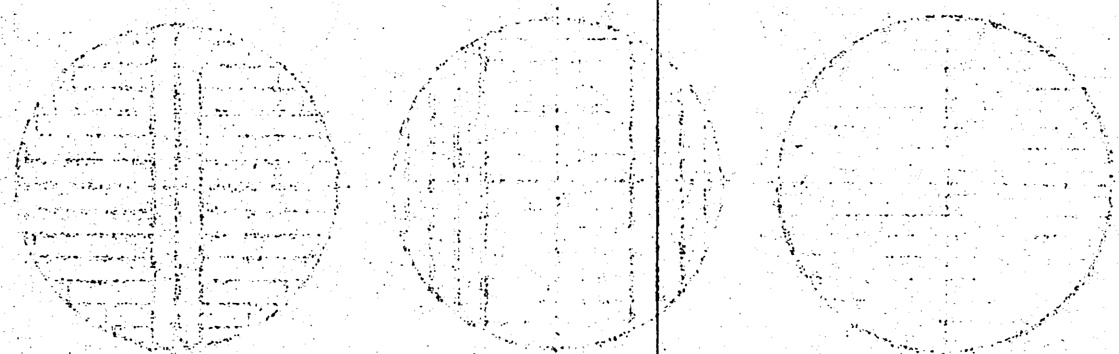
Reducing Idle Time

Another method of reducing the price per finished piece is to decrease idle time. This can be measured as time with head saw shut down or non-productive work, idleness, and delays. However, the mill could still be producing lumber because they are taking time to reprocess waste material.

Maintenance and other essential tasks are another example of non-productive time. Changing blades and loading logs are essential tasks, but do not directly contribute to total output (Salvador et al. 2020).

Some of this non-productive time can be reduced by maintaining a well organized facility. It is important that double handling of wood be avoided wherever possible. There should be clear foot paths to avoid trip and fall injuries. Logs should be positioned near the mill with equipment when possible. Figure 7 shows one such

involves cutting a square beam, or cant, from a log and then sawing it top to bottom. This method, also called flitch sawing, produced only 7% rough grade lumber. However, it had a total recovery of 84% (Milkovsky et al. 2020).



Quartersawing Cant sawing Through and Through sawing

Figure 5 Log sawing patterns (... et al. 2018)

Reducing Idle Time

Another method of increasing the price per finished board is to decrease idle time. This can be measured as time with head saw clutch open or non-productive work, idleness, and delays. However, the mill could still be producing lumber but at a reduced rate and cutting time to reduce waste material.

Maintenance and other essential tasks are another example of non-productive time. Changing blades and loading logs are essential tasks, but do not directly contribute to total output (Salminen et al. 2020).

Some of this non-productive time can be reduced by maintaining a well organized facility. It is important that double handling of logs be avoided wherever possible. There should be clear roadways to avoid trip and fall injuries. Logs should be positioned near the mill with equipment when possible. Figure 6 shows one such

example of a well organised log yard. Note the multiple lumber sorts out of the way, wind at the operators back, and logs close to the mill. An improvement would be to include a rack for the slabs so they can be bundled and handled with equipment where possible (Folkema 1992).

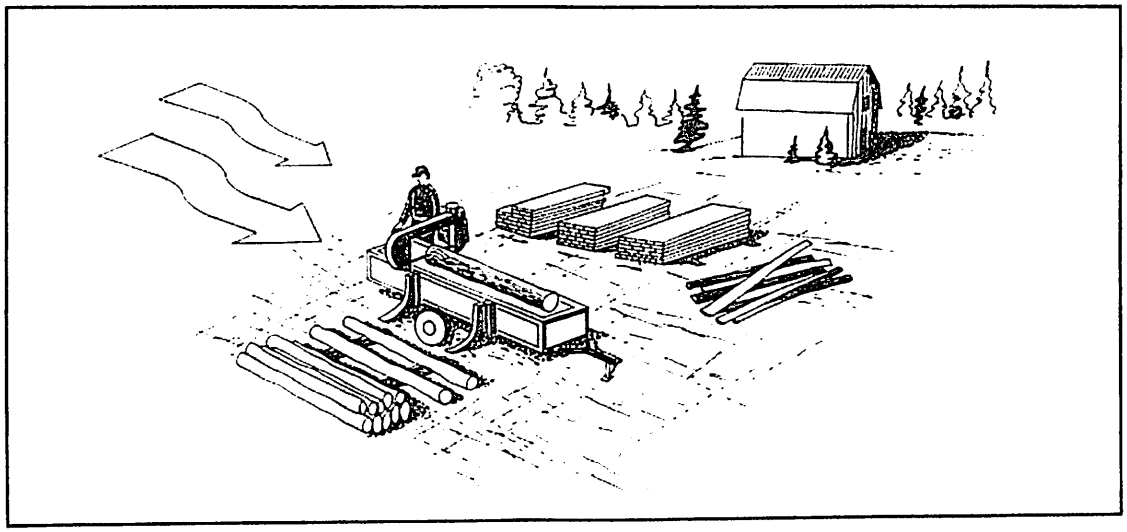


Figure 7: Portable Saw Mill Facility Layout (Folkema 1992)

Ngobi (2020) found that operators can improve efficiency by cutting logs in batches. Logs come in a large variety of sizes, and a sawyer can make mistakes when applying his saw pattern to the log. The study recommends that logs be sorted in the yard by diameter of the smallest cut end. The example given was to create 3 size classes with 10-centimeter increments. This study found an increase in recovery of up to 14%.

Similarly to Ngobi (2020), other studies have found similar improvements to efficiency when logs are well sorted. De Lasaux et al. (2009) focused on lumber recovery from precommercial thinning residue. The material was sorted into similar size classes. There was high importance placed on removing uneven or misshapen logs

from the stockpile. The result of this was very high efficiency. However, they note that it is critical to have an adequate supply of logs. They found no less than 50 cubic meters of logs were required to keep costs to an appropriate level. The increased downtime due to insufficient stockpiles led to large increases in the cost of production.

Increasing revenue through value-added products

Traditional sawmill businesses have had a production orientation. They focus on producing a high volume of identical product at the lowest price. There may be a decrease in quality, and less attention is paid to the customer needs and wants. By comparison, modern companies utilize a marketing orientation. The customer demand is first identified, and then production works to meet those demands (Sherman 2022).

It is generally accepted that shifting the forestry industry towards higher value goods will increase its contribution to the GDP. The production of high value goods will allow for more research and better care of forests, something which will be needed in the future (Sathre and Gustavsson 2009). Value added products are less susceptible to price changes of the supply material. Sawn and planed wood provides higher value than only sawn lumber, and each additional step adds still more value.

Focusing on value-added products can increase a company's profit margin significantly. The simplest definition of a value-added product is performing additional manufacturing steps to a product beyond its initial form (Kozak et al. 2004). By doing this a company does not have to compete on price, such as in a commodity market. They can focus on producing a unique, higher value product. In the sawmill industry

this could include surfaced lumber, drying, providing molding or jointing, or producing other higher value wood products. They allow a small business to differentiate itself from other low cost competitors (Roos et al. 2002). Businesses which focus on adding value to their products are more likely to succeed in the future as competition increases.

Various sawmill manufactures offer add on options and additional tooling to their mills which allow for the creation of these high value products. One such example is the wood mizer planer/moulder. This allows lumber to be upgraded in value multiple times. A 1x6x8 knotty pine board is worth $1.85 per bd ft. However, the same board with a tongue and groove finish is worth $2.64 per bd ft, an increase of 42%. At this rate it would take approximately 95 hours of production at 20 ft per minute to recover the initial $29,995+hst investment (Home-Depot 2024; Wood-Mizer 2024b).

Wood-Mizer offers other options, including the lathe-mizer, a shingle attachment, and a shiplap tool as ways to increase the value of the sawn timber. The lathe-mizer retails for only $4583. This can be used to turn small, low value logs into posts and beams. These products will provide a much higher return than a 4x4 or 6x6 inch beam. For example, a 6 sided post retails for $73 dollars, while a 4x4x8 cedar post sells for $41.76 each. The sawing time is slightly increased, requiring about 10 minutes to create a post compared to 5 minutes for a 4x4x8. However, the lathe-mizer, with HST, would have recovered its value after 167 finished posts. This would take about 27 hours, or less than a week's production. These are two excellent value added

opportunities which can boost a small sawmill's profit ("Porcupine 4X4X8 PREMIUM KNOTTY CEDAR POST" 2024; Wood-Mizer n.d.).

Figure 8: 6 Sided Post Created by Lathe-Mizer Attachment (Youtube)

Value-Added Services

Dark (1977) finds that another avenue for sawmill owners to increase the value of their time is to offer portable sawmilling as a service. This option is desirable because it avoids the need to hold an inventory of logs. This market can be less saturated due to less competition from larger operations. There is no need for insurance required when hauling logs on public roads. The pay rate is not tied to the production rate, although there is an expectation of productivity and quality from the customer. People offering this service usually charge by the hour or by the thousand board feet cut.

Pinkerton and Benner (2013) found that smaller mills survived industry slowdowns better than larger commodity mills. Their higher revenue and better integration allowed them to continue operating at a reduced rate. The higher profit margin provided by value-added goods makes them willing to operate at a reduced

capacity. They may also be required to operate at this capacity, as they must maintain customers and suppliers. These relationships take years to build, and a complete closure during a slow period may lead to lack of customers when the mill restarts. This is also beneficial for retaining staff.

These small mills may have as many as 60 different sorts, or products produced. These include trim and fascia, furniture blanks, fencing, siding, and flooring. Many of these products may be consumed when other products such as dimensional lumber is not (Pinkerton and Benner 2013).

Opportunities

Houdek and Baumeister (2007) conducted a survey of feasibility in the Northwest Territories and found that there was some demand, but not enough to maintain an industry. They recommended that operators work to increase the consistency of their product to attract buyers. As well, there should be a focus placed on producing more dried lumber, grading, and eventually higher value products. In the longer term the official recommendation by (Houdek and Baumeister 2007) was to focus on higher value products. Initial investments should be made in product lines which are similar to that currently being run, for instance a flooring or wall paneling line. As customer confidence returns and grows in the new product then larger orders can be placed. Equipment such as a moulder could be purchased in the future, adding options for more value-adding such as tongue and groove. Houdek and Baumeister (2007) also mention a transition into log home building. While this is relatively

capacity. They may also be required to operate at this capacity, as they must maintain customers and suppliers. These relationships take years to build, and a complete closure during a slow period may lead to lack of customers when the mill restarts. This is also beneficial for retaining staff.

These small mills may have as many as 50 different sorts of products produced. These include trim and fascia, furniture blanks, fencing, siding, and flooring. Many of these products may be designed when other products such as dimensional lumber is not (Pemberton and Donner 2006).

Opportunities

Houdek and Bannister (2007) conducted a survey of feasibility in the Northwest Territories and found that there was some demand, but not enough to maintain an industry. They recommended that operators work to improve the consistency of their product to attract buyers. As well, there should be a focus placed on producing more dried lumber, grading, and eventually higher value products. In the long-term the critical recommendation by Houdek and Bannister (2007) was to focus on higher value products. Initial investments should be used in product lines which are similar to that currently being run, for instance a flooring or wall paneling line. As customer acceptance returns and grows in the new product then larger orders can be placed. Equipment such as a four sider could be purchased in the future, adding options for more value-adding such as tongue and groove. Houdek and Bannister (2007) also mention a transition into log home building. While this is relatively

unrelated to sawmilling, it provides the opportunities of reduced saw cost and material handling. It would require retraining and restaffing to ensure the best productivity.

Clustering can be another excellent option for reducing cost and complexity. By grouping multiple businesses in the supply chain geographically near each other, transport costs can be reduced. Lead and delivery times are also reduced, allowing for less inventory to be kept on hand. This allows a business to be more agile and flexible (Nicholls and Bumgardner 2018). Green supply chain is another strategy which is being adopted. It focuses on developing value driven suppliers who focus on the needs of their specific customer. There is a shift towards just in time manufacturing, less defect in product, and better communication and collaboration between manufacturer and consumer. This can reduce cost by reducing waste, management cost, and allows for a higher price to be charged.

Value-Added Products from the Waste Stream

Bark can be resold for several purposes after it is removed from a log. A debarker can help to mulch it into an appropriate size, or else it can be mulched using appropriate equipment. Once processed, it can be sold as landscaping mulch, for composing or potting mix, or to aid in mine reclamation. The bark helps to create better microsites which allow for better rehabilitation. This option can be significantly cheaper than others (Blackwell and Stewart 2003). Tree bark can also be used for animal bedding. It is desirable because it contains little dust, helps absorb excess moisture, and reduces ammonia emissions. The used bedding can be turned into compost or fertilizer (Pandey 2022).

Wood chips can also be sold for similar uses. These work well for landscape cover and can also be used in playgrounds or parks. The wood fibre can be burned for energy or converted into wood pellets using a pelletizer. (Mokhtar et al. 2022).

Conclusion

Small sawmills provide a great business opportunity. Their low cost of entry and ownership, earning potential and recovery of investment are all reasons why this is a popular choice. However, there can be competition from large mills and other local operations. Profits can be thin, and new owners may not be aware of efficiencies and opportunities available. These can be the difference between viability and failure. This literature review looks at 3 major areas where a mill can gain an advantage.

These are to increase throughput or production, to decrease costs associated with production, and to focus on value added products. Better blade choice, sorting logs, better saw patterns, and marking logs before sawing can help increase throughput of a mill. Costs can be reduced by focusing on increasing sawing and measuring accuracy to reduce waste, investing in capital to increase production, and reducing idle time. There are many methods available to add value to mill products. Focusing on additional processing of lumber, such as planning, drying, molding, and laminating can improve profit with less investment in new equipment. Laminated timbers have some of the highest values but may not be feasible for small mills. Selling wood chips, bark, and other waste allows for more of the cost of the log to be

recovered. Portable sawing can be another great opportunity with its reduced competition.

There are many strategies available to the mill owner, and this is not a complete list. More research into focusing on complete wood products such as deck kits, gazebos, and furniture should be done, as this is likely to provide even higher value. It should be noted that the first two areas of improvement will provide only marginal gains of up to about 25%, while transitioning to value-added products can increase revenue by multiple times.

There is opportunity for success in the small sawmill category, although care must be taken to avoid some of the mistakes made by others. Value-added products will likely grow in importance in the future as competition grows tighter.

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