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Chain Saw Chains: Analyzing Sharpening Options and Practices for Operational Efficiency

By Alexander Martin

Abstract. Background: Chain saws are a primary piece of equipment in arboriculture. Sharpening of chain saw chains is important to the chain saw's continued efficient cutting power. Analyses of chain saw sharpening procedures can influence efficiency and sustainability in arboriculture. Previous research has examined mechanical aspects and variability of chain saw chains; however, a knowledge gap exists regarding sharpening methods relating to operational efficiency. Methods: Chain saw chains retired from operational service were submitted by 132 arboriculture crews from 47 companies across a 6-month period. The research team reviewed 640 chain saw chains to determine whether the functionable lives of the chain saw chains had been exhausted. If the functionable life was not exhausted, the remaining functional life of the chain was documented. To analyze the accounting cost and economic cost of sharpening versus purchasing new chain saw chains, an economic model was created with variables from chain saw chain manufacturers and geospatial data. Results: Of the submitted chain saw chains, 77% (n = 493) were retired before their functional life was exhausted. The mean number of additional times that the chains could have been sharpened was 4.54 more times (σ = 2.22). Per the economic model, accounting costs of purchasing new chains were 3.64 to 4.96 times more expensive than sharpening chains in-house. The economic cost of purchasing a new chain was generally 1.83 to 3.74 times more expensive than sharpening chains in-house. Conclusion: This study demonstrates that the functional service life of chain saw chains are frequently not exhausted and that purchasing chains has higher accounting and economic costs than sharpening chains in-house.

Keywords. Arboriculture; Business Decisions; Cutter Teeth; Sharpening Techniques; Urban Forestry Management.

INTRODUCTION

Operational efficiency and analysis of financial decisions are important components of business operations. Within arboriculture, operational analyses can range from vehicle-maintenance scheduling to clearance pruning intervals to small-equipment management. A repetitive practice within the tree care industry is the care and maintenance of chain saws. While there are many brands and variations of chain saws, the overall system generally remains the same: a motor drives a chain at great enough speed for the cutters of the chain to cut wood (Warguła et al. 2020). Thusly, chain maintenance and sharpening are integral to operational efficiency and the proper functioning of the chain saw (Maxwell 2002; Andrews 2020; Poje and Mihelič 2020).

Determining when a chain saw chain needs to be sharpened is qualitative rather than quantitative. Arborists will typically determine that a chain saw chain needs sharpening by factors such as reduced cutting speed of the chain saw chain over time, the chain saw chain producing lighter and smaller cuttings akin to sawdust, and any dulling or blunting occurring to the chain saw chain from coming into contact with rocks, metal, soil, or other hard nonwoody materials (Maciak and Kubuśka 2018). While dull chain saw chains will decrease the cutting speed and increase the stress placed on the chain saw, there may be variation in when arborists choose to sharpen their chain saw chains relative to these aforementioned factors.

Many different techniques exist for sharpening chains, some reflective of the various chain types on the market, and chain saw users may modify sharpening techniques to the perceived benefit of greater cutting efficiency (Poje and Mihelič 2020).

Previous publications on chains have included discussions of innovations in chain-link systems for rescue purposes (Warguła et al. 2020), cutter sharpening

angles and their impact on likelihood of kickback (Silverio 1993), implications of chain filing on particle distribution (Marenče et al. 2017), and variability in cutting force (Maciak et al. 2018).

There is little research on determining a quantitative threshold beyond which chain saw chains should be retired. While there is limited discussion on the subject in scholarly writing, arborist and homeowner "do-it-yourself" advice websites suggest qualitative indicators, such as broken teeth or uneven wear, stretching of the chain, the chain smoking despite proper lubrication, imperfections of the drive links, and/or chain saw depth gauges being too low to continue sharpening the chain (Boll 2018; McLeod 2018; Chapman 2021; JJ [date unknown]). Some manufacturers will include lines on the cutter head, indicating the limit of sharpening of the cutter head (Chapman 2021; JJ [date unknown]). According to Chapman (2021) and JJ [date unknown], sharpening beyond this point can result in the chain breaking during operation. However, a thread titled "Ever had a chainsaw chain break" on the Firewood, Heating and Wood Burning Equipment forum on ArboristSite.com (gwiley 2009) included a number of people reporting chains breaking because of hitting metal while cutting or chains jumping off the bar guide; there was no mention of chains breaking as a function of over-sharpening. One comment on the thread mentions not sharpening past the marked line on the cutter head (ctrees4$ 2009).

When purchasing new chains, arborists may choose to purchase chains fit to the size of the guide bar of their chain saws or purchase bulk chain saw chain spools, punching the chain links to size as necessary. The latter option has been excluded from this study due to its limited usage among the sampling pool and a high variability in the cost of spools among different distributers.

Despite the operational importance of chains, qualitative data on chain saw sharpening accuracy to the benefit of analyzing operational efficiency is insufficient or not readily available. Additionally, management solutions for increasing workplace efficiency are limited. By recognizing and addressing areas of waste or shortfall and encouraging a paradigm shift in company practices, companies are able to better structure themselves for long-term resiliency (Ortiz-de-Mandojana and Bansal 2015).

In order to address the knowledge gap on management of chain saw chains, this study sought to examine methods for chain maintenance and sharpening. Four research questions were posed: (1) Do companies regularly exercise the full functional life of the chain saw chains? (2) If not, to what extent are chain saw chains retired too early? (3) How do spatial and temporal factors influence accounting and economic costs of chain saw chains? (4) What practices might better improve operational efficiency with regard to chain saw chain sharpening and maintenance?

METHODS

Research Questions 1 and 2

Data Collection

In examining the first 2 research questions, this study designed methodology by which chain saw chains were collected from companies that believed the chains had reached the end of their functional life and were retired from service. Inclusion criteria for the arboriculture companies required that the companies had been in sustained operation for at least 1 year and included crews carrying out routine operations without the owner of the company participating on the crew. The latter inclusion criterion was specified to minimize the impact of demand characteristics wherein knowledge of one's own involvement in a study impacts the behavior of the participant (McCambridge et al. 2012). Companies must also have access to a chain saw shop within 10 km of their normal operating area to reduce the influence of rural arboriculture companies that may adapt chain saw chain handling methods based on limited access to chain saw chain shops.

Companies were contacted through mixed-method contact attempts, which included Facebook postings, forum postings, and mail. According to Beebe et al. (2018), the use of multiple methods for participant/contributor recruitment yields increased response rates and greater diversity in contributors. This study used a 3-person contact team comprised of arborists with field-based experience who maintained communication with the principal investigator during the recruitment stage. This structured system was based on insight from Ringnér and Olsson (2021) who found that nurse-supported recruitment of participants under a structured stakeholder process yielded higher recruitment rates.

Following the mixed-method contact attempts, 73 companies contacted the research team interested in participating in the study. Of these 73 companies, 26 companies (35.62%) were unable to partake in the study, as they did not meet the inclusion criteria, and 47 companies (64.38%) were retained for the survey. Within the 47 companies, a total of 132 crews were instructed to submit at least 20% of all of their chains or 10 chains (whichever was least) of those that they considered to be at the end of their service life and had planned to retire. The chains were collected over a 6-month study period at a central location and tagged with a unique identification number. The unique identification numbers were used to anonymize the submitter of the chains.

In total, 883 chains were submitted by 132 crews. The mean number of chains submitted by each crew was 6.689 chains with a median number of 9 chains and a standard deviation of 2.315. During initial processing, 243 chains (27.52%) were rejected for being in a broken or altered state where filing would not fix their damage, thus typically necessitating retirement. Rejected chains included those with broken cutters, broken rivets, burred drive links, and rusty chains. These chain conditions were excluded from the study as the maintenance procedures for these issues fall outside the scope of the research project regarding sharpening of chains to continue their functional service life. Further, in cases where chains were rusty, it was not possible to determine if the rust was the cause of the retirement of the chain or if the chain became rusted during storage before being sent to the research team. As a result, rusty chains were excluded from the study.

Data Analysis

The chains were distributed among 27 chain saw chain reviewers on the research team that were selected based on continued professional experience with chain saw chain sharpening, including sharpening staff in chain saw dealers/shops. The reviewers were asked to complete a Microsoft Excel (version 2107; Microsoft, Redmond, WA, USA) spreadsheet that asked whether the chains could be filed more (answered as "YES" or "NO") and to estimate how many more times they could be filed.

Accuracy of the sharpening projections was standardized using 35 chains that were filed to various wear points. The artificially worn chains were placed at random intervals within the collected chains to be reviewed such that the principal investigator could assure congruency between the various reviewers across the measurements.

The initial methodology for review was based on the length in millimeters from the trailing end of the top plate of the cutter to the mean point of the leading edge. However, this was determined to have greater variability in estimated longevity due to difficulties in measuring when there was damage to the side plate cutting edge that would require additional sharpening to remove. Thusly, the adapted method used for this study based retirement on visual inspections which was demonstrated to be a successful comparative method. Included within the visual inspections were the use of depth gauge measuring tools (products sold as "depth gauge" by Stihl® [Virginia Beach, VA, USA] and Husqvarna® [Stockholm, Sweden]—not to be confused with the chain saw chain component) which were used to determine whether the depth gauge was too low to be filed again. If depth gauges were below the tool's gauge, it was determined that the chain could not be filed further.

Because the chains were the source of data and personal information was not solicited from either participants/contributors or reviewers of the chain saw chains, the study doesn't involve "human participants" and is not included within the scope of research requiring review from a research ethics board (REB) as specified in Article 2.1 of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (Canadian Institutes of Health Research et al. 2018). Whereas the opinions of the chain saw chain reviewers regarding chain longevity are being recorded, the reviewers are being used as experts in the determination of answers to the research questions about equipment longevity, and their responses are thusly exempt from required review from an REB.

Research Question 3

In answering the third research question, this study used geospatial network analyses, the retail prices of chain saw chains, and the cost of professional sharpening to build multiple simulated business scenarios (economic models). Economic models provide an overview of aspects of an economic environment applicable to the scenario to be analyzed (Parkin and Bade 2018).

For the purposes of this methodology, accounting cost refers to the costs incurred directly (i.e., the cash

and cash equivalents exchanged for goods and services). The economic cost is used in reference to the opportunity cost of operations, which includes both the exchange of cash and cash equivalents for goods and services and the indirect costs, such as "down time" or deferred time from operations (Parkin and Bade 2018). As an example from this study, economic cost recognizes the inability to produce operational income while driving to purchase a new chain. The outputs of the economic model compare sharpening chains, purchasing new chains, or having chains professionally sharpened from both accounting-cost and economic-cost perspectives.

Variables within the simulations included (1) time to sharpen the chain or drive to a chain saw dealer/miscellaneous chain saw chain supply store; (2) cost of sharpening supplies; (3) labor costs; (4) travel costs; (5) frequency with which chains were sharpened or purchased; (6) median hourly revenue of the crew to determine the economic cost of both options; and (7) the cost of professional sharpening. Because an infinite number of variable situations can be created, spatial and inventory statistics have been limited to 38 crews within the study. Excluded from this economic model is the use of chain saw chain spools because of high variability in spool pricing and its limited use among arboriculture crews included in the economic model; of the 38 crews within the study, only 2 crews (5.26%) used chain saw chain spools, although they did not use this method regularly.

Fixed variables included in the economic model are an average crew revenue of $300 Canadian dollars (CAD) per hour and an average crew income of $125 CAD per hour. The economic model assumes that all chains in the inventory less one per the number of saws in the inventory are taken to be sharpened at one time. The economic model assumes that the number of new chains purchased does not exceed 10% of the inventory of the crew's total chains. The economic model assumes that sharpening time is linear and increased with increased number of cutting teeth. This accounts for skip-tooth chains, used primarily at larger chain saw bar lengths. Each time that chains are sharpened, the summed initial setup and cleanup time is 5 minutes. It is assumed that chain saw chains are sharpened on the jobsite, rather than at a central location.

The time to file 1 chain was based on the average of self-reported chain saw chain sharpening times collected from the 27 research team members across a 4-month period. Each bar length has its own attributed time requirement based on a minimum of 150 chain sharpening time samples. Bar lengths included in the economic model are 35.56 cm (14 in), 40.64 cm (16 in), 45.72 cm (18 in), 50.8 cm (20 in), 91.44 cm (36 in), and 121.92 cm (48 in). The life span of supplies used in sharpening is based on the mean life span reported by the research team members with a minimum sample size of $n = 3$ (raker file) and a maximum sample size of $n = 26$ (cutter file).

To determine the influence of spatial factors on costs in the simulation, overlay maps were created using a service-area analysis layer in ArcGIS Pro (Esri Inc., Redlands, CA, USA). The distances from chain saw dealers and miscellaneous chain saw chain supply stores were used to construct categorical data classes for distances from supply locations. Categorical data allowed for the calculation of driving expenses, including gas and wages for employees driving and the accounting cost of missed work.

To determine the expense of chain saw chains, the retail price of chain saw chains of various pitches and bar lengths was collected from Stihl®, Husqvarna®, and Echo® (Yamabiko Corporation, Ome, Japan) dealers from Winnipeg, Manitoba, and Vancouver, British Columbia. The same methodology was used in the determination of the expense of professional sharpening.

An Excel spreadsheet was created to sum the accounting costs and economic costs of potential scenarios. For calculation of the mean, outliers were removed using the *z*-score threshold where samples of the data at 3.0 standard deviations or greater were removed.

RESULTS

Research Questions 1 and 2

In total, 640 chains were reviewed by the research team. Of these 640 chains, 77% ($n = 493$) of the chains could have been filed at least once more to continue the functional service life of the chain. Of these chains ($n = 493$), the mean number of additional times that the chain could have been filed was 4.54 times with a median of 4 and a mode of 4 (Figure 1). The standard deviation of the distribution was 2.22 and a variance of 4.93. Note that an open class was used to accommodate for extreme observations in the data set in the 10+ interval (Kozak et al. 2008). The open-ended class interval for 10+ times was analyzed as a value of 10 (Kozak et al. 2008).

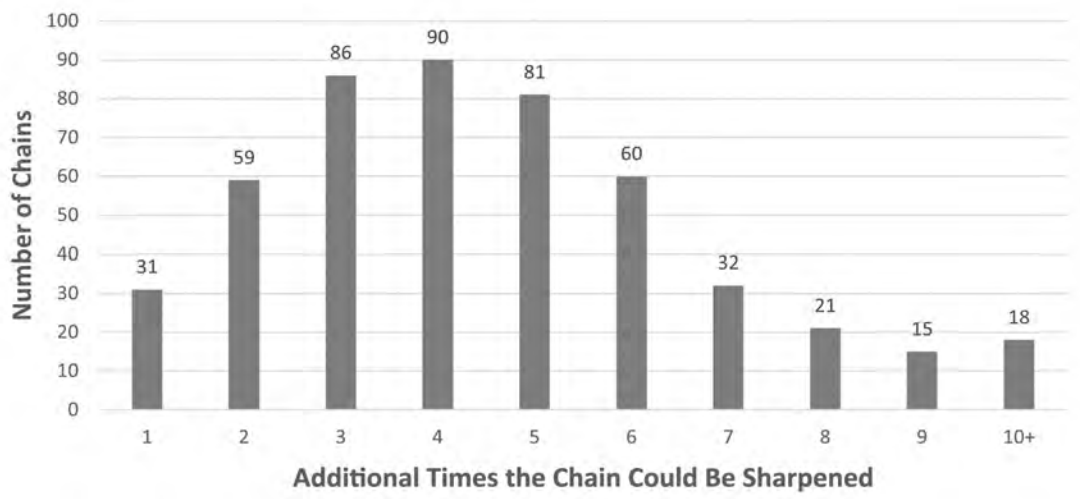

Figure 1. Frequency distribution of 493 chains grouped by the number of additional times that the chain could be sharpened before reaching the end of its functional life.

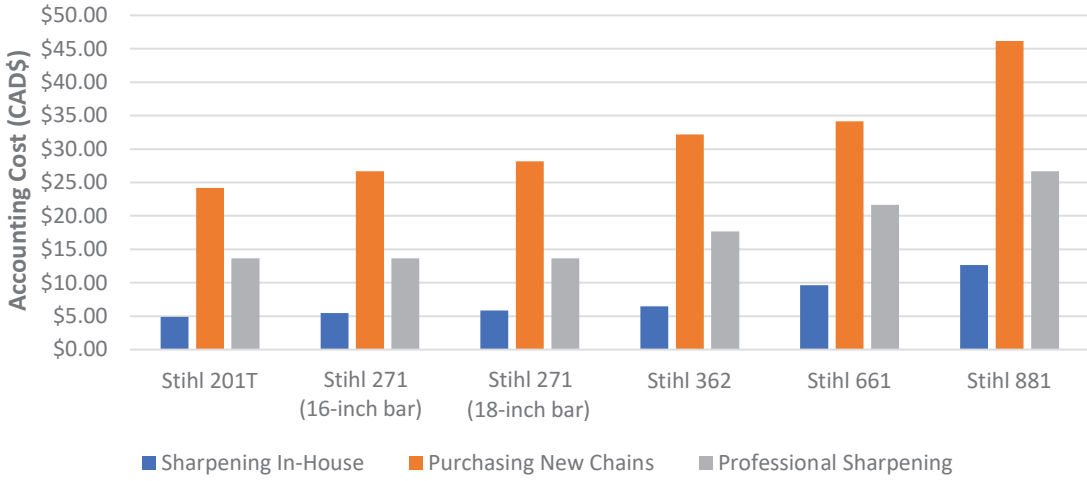

Figure 2. Accounting costs of 3 methods of chain saw chain management. The accounting costs are reflected in Canadian dollars (CAD). The accounting costs shown here are for common Stihl® chain saws used in arboriculture operations.

The remaining functional service life of the chains (i.e., the number of additional times the chain may be sharpened) has a positively skewed distribution.

Research Question 3

Figure 2 shows the accounting costs of sharpening chain saw chains in-house, purchasing new chains, and professional sharpening. The accounting cost of sharpening in-house was less than the 2 other methods. The accounting cost of professional sharpening was less than the accounting cost of purchasing new chains. In examining the accounting cost, this study includes direct expenses incurred, such as the cost of chains and sharpening equipment; however, it does not reflect the opportunity costs, such as the downtime incurred by driving to purchase new chains.

The results of the economic modeling for accounting cost (i.e., only direct expenses incurred) show that for 95% of the situations run through the economic model, the accounting cost of purchasing a new chain was generally 3.64 to 4.96 times more costly than sharpening the chain in-house. The mean accounting cost of purchasing a new chain ($\bar{x}_1$ = $31.92 CAD) was 4.26 times greater than the mean accounting cost of sharpening a chain in-house ($\bar{x}_2$ = $7.49 CAD). The accounting cost of having a chain professionally

sharpened was between 2.10 and 2.81 times greater than sharpening the chain in-house. The mean accounting cost of professional sharpening ($\bar{x}_3$ = $17.83 CAD) was 2.38 times greater than the mean accounting cost of sharpening a chain in-house ($\bar{x}_2$ = $7.49 CAD).

Figure 3 shows the economic costs of sharpening chain saw chains in-house, purchasing new chains, and professional sharpening. The economic cost includes the accounting costs (i.e., direct expenses incurred) and the additional opportunity cost. The economic cost of sharpening in-house was less than the 2 other methods. The economic cost of purchasing new chains was less than the economic cost of professional sharpening.

The economic modeling determined that for 95% of the situations run through the economic model, the economic cost of purchasing a new chain was between 1.83 to 3.74 times greater than sharpening the chain in-house. The mean economic cost of purchasing a new chain ($\bar{x}_4$ = $119.20 CAD) was 2.69 times greater than the mean economic cost of sharpening a chain in-house ($\bar{x}_5$ = $44.30 CAD). The economic cost of having a chain professionally sharpened was between 2.76 and 6.32 times greater than sharpening the chain in-house. The mean economic cost of professional sharpening ($\bar{x}_6$ = $192.83 CAD) was 4.35 times greater than the mean economic cost of sharpening a chain in-house ($\bar{x}_5$ = $44.30 CAD).

DISCUSSION

The prevalence of chain saw chains retired before the end of their functional life is of great enough proportion that it might be of concern to company operations. This is supported by the distribution of the remaining functional service life of the chains, indicating that either operators may not be aware of the full potential service life attainable from their chains or company policies may not allow for the functional service life to be realized. Consulting with a chain saw dealer or other professional service person who sharpens chain saw chains may help to indicate potentially wasteful operational procedures. As highlighted by these results, companies may find value in communicating to their crews that chains should not be retired unless they have been sharpened thoroughly.

In the economic modeling results, the difference in accounting cost and economic cost generated by the economic modeling is most attributed to reduced downtime through purchasing multiple chains at one time or taking multiple chains to the third-party professional sharpener at one time. Both economic and accounting costs increased at increased chain lengths (bar lengths). However, the relative cost magnitude of purchasing new chains and professional sharpening compared to sharpening chains in-house shows a decrease in relative magnitude at increased chain lengths (bar lengths). This indicates that as chain lengths increase, purchasing new chains or using professional sharpening as alternatives to in-house sharpening becomes more comparable.

In reviewing the fourth research question, economic models were reviewed to determine components of operational management which have the greatest reduction in accounting and economic costs.

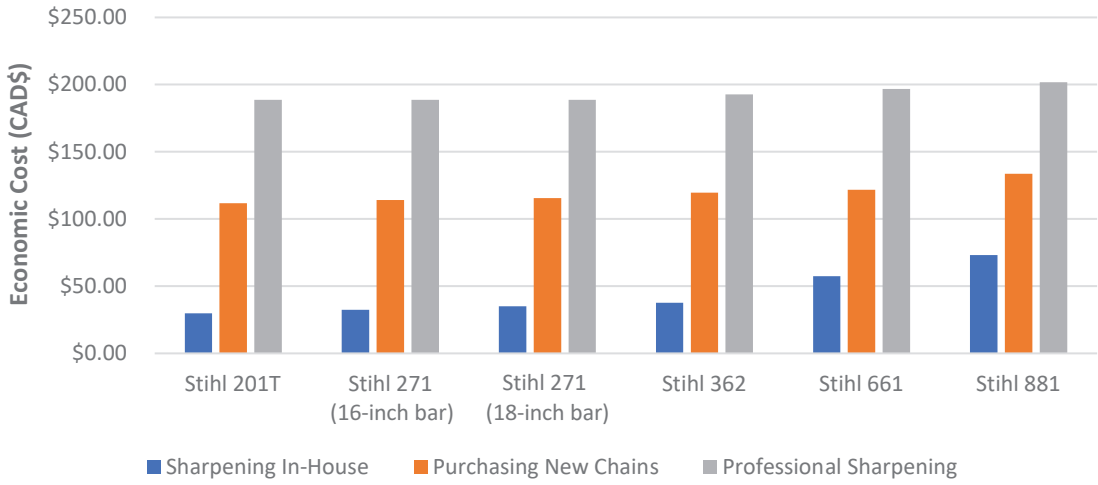

Figure 3. Economic costs of 3 methods of chain saw chain management. The economic costs are reflected in Canadian dollars (CAD). The economic costs shown here are for common Stihl® chain saws used in arboriculture operations.

From the economic modeling, 3 opportunities were highlighted for reducing accounting and economic costs during normal business operations. Firstly, purchasing the chains when crews are operating at close proximity to a chain saw chain supplier helps to reduce the driving expenses and lost-time costs. Secondly, having new crew members purchase chains allows senior arborists to continue working, reducing the amount of lost time. Thirdly, by centralizing the chain saw sharpening, the accounting cost and economic cost differentials between sharpening and purchasing chains are heightened.

The third method may involve employing an individual specifically to sharpen chains. This can be done when a crew maintains a large chain inventory which helps them to accumulate dull chains. Once a set threshold has been reached, an individual from the company sharpens the chains at the business's central location and readies the chains for the next operational day. The benefits of hiring an employee to sharpen chains were reduced time per chain (as the sharpening equipment was centralized and ready to go) and reduced downtime for operations crews in the field. The work could be carried out at the work yards in order for the operations crews to have access to the sharpened chains for the next day of work.

Of additional note, the economic modeling indicates that a higher frequency of purchasing new chains in lower quantities is not as impactful to companies working in more urbanized environments with closer access to chain saw dealers and miscellaneous chain saw chain supply stores. This underscores the importance of proper chain saw chain maintenance regimes in areas of rural or remote work, including utility-vegetation management, logging, or storm and natural disaster response.

Alternative sharpening methods that may influence accounting and economic costs which were not included within the economic model include buying chains in bulk spools, punching to length as needed. Further research on buying chain in bulk would help to illustrate whether such a method reduces opportunity cost of operations and accounting cost.

Further research on chain saw chain sharpening might focus on demographic variables and decision-making processes at the crew and company levels to illustrate how choices are made concerning daily procedure business decisions. Behavioral studies building upon this study may help indicate whether proximity to a chain saw dealer influences the decision to sharpen or purchase a new chain. By comparing owner-operator–run crews versus employee-run crews, it might be determined how self-interest modeling could be used to predict behaviors based on the incentives realized in this study. Such a behavioral study would be in the interest of the economics of arboricultural operations (Parkin and Bade 2018). Additionally, examining owner-operator companies versus crews that operate without owner involvement may indicate how operational practices might differ as independence of the crews increases.

An additional area of review may include how chain saw operator training impacts the frequency with which chain saw chains are retired before the end of their usable life.

CONCLUSION

This research demonstrates how companies frequently underutilize the full functional service life of their chain saw chains. Accounting and economic costs of purchasing new chains and professional sharpening have higher costs compared to sharpening in-house for all situational variables tested in the economic model. Additionally, whereas sharpening chains in-house sees a large cost differential compared to purchasing new chains and professional sharpening at shorter chain lengths, as chain lengths increase, the alternative methods become more comparative.

In a world with increased accessibility to open-source mapping, cost predicting, and statistical software, the adoption of micro-expense analyses to explain your operating decisions can highlight potential vulnerabilities in daily decision making. Recording your operations can be as simplified as an Excel spreadsheet with expense receipts amongst different crews or may include operational management statisticians. By taking the time to record data, businesses have the opportunity to highlight areas of potential expense reduction and keep crews functioning efficiently.

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Conflicts of Interest:
The author reported no conflicts of interest.

Résumé. Contexte: Les scies à chaîne sont un outil et un équipement essentiel en arboriculture. L'affûtage des chaînes de tronçonneuses est essentiel afin que cet outil conserve une puissance de coupe efficace. L'analyse des pratiques d'affûtage des tronçonneuses peut influencer l'efficacité et la durabilité en arboriculture. Des recherches précédentes ont examiné les aspects mécaniques et la diversité des chaînes de tronçonneuses; cependant, il subsiste un manque de connaissances en ce qui a trait aux méthodes d'affûtage en lien avec leur efficacité opérationnelle. Méthodes: Des chaînes de tronçonneuses, retirées du service opérationnel, ont été récupérées auprès de 132 équipes d'arboriculteurs provenant de 47 entreprises durant une période de 6 mois. L'équipe de recherche a examiné 640 chaînes de tronçonneuses afin de déterminer si leur durée de vie fonctionnelle avait été excédée. Si cette durée de vie fonctionnelle n'avait pas été atteinte, la durée de vie utile résiduelle de la chaîne était alors documentée. En vue d'analyser le coût comptable et le coût économique de l'affûtage par rapport à l'achat de nouvelles chaînes de tronçonneuses, nous avons créé un modèle économique avec des variables provenant des fabricants de chaînes de tronçonneuses et de données géospatiales. Résultats: Parmi les chaînes de tronçonneuses soumises, 77 % (n = 493) ont été mises hors service avant d'avoir atteint la limite de leur durée de vie fonctionnelle. La moyenne du nombre de fois additionnelles où les

chaînes auraient pu être encore affûtées était de 4,54 fois (σ = 2,22). Selon le modèle économique, les coûts comptables pour acheter de nouvelles chaînes étaient de 3,64 à 4,96 fois plus élevés que l'affûtage des chaînes en régie. Le coût économique de l'achat d'une nouvelle chaîne était généralement de 1,83 à 3,74 fois plus onéreux que celui de l'affûtage des chaînes en interne. Conclusion: Cette étude démontre que la durée de vie fonctionnelle des chaînes de tronçonneuses n'est souvent pas atteinte et que l'achat de chaînes montre des coûts comptables et économiques plus élevés que l'affûtage des chaînes en régie.

Zusammenfassung. Hintergrund: Kettensägen gehören zu den wichtigsten Ausrüstungsgegenständen in der Baumpflege. Das Schärfen der Kettensägenketten ist wichtig, damit die Kettensäge weiterhin effizient schneiden kann. Eine Analyse der Schärfverfahren für Kettensägen kann die Effizienz und Nachhaltigkeit in der Baumpflege beeinflussen. Bisherige Forschungsarbeiten haben sich mit den mechanischen Aspekten und der Variabilität von Kettensägenketten befasst; es besteht jedoch eine Wissenslücke hinsichtlich der Schärfmethoden in Bezug auf die betriebliche Effizienz. Methoden: Ausgemusterte Kettensägenketten wurden von 132 Baumpflegemitarbeitern aus 47 Unternehmen über einen Zeitraum von 6 Monaten eingereicht. Das Forschungsteam überprüfte 640 Kettensägeketten, um festzustellen, ob die Nutzungsdauer der Kettensägeketten erschöpft war. War die Nutzungsdauer nicht erschöpft, wurde die Restnutzungsdauer der Kette dokumentiert. Um die buchhalterischen und wirtschaftlichen Kosten des Schärfens im Vergleich zum Kauf neuer Kettensägeketten zu analysieren, erstellten wir ein Wirtschaftsmodell mit Variablen von Kettensägekettenherstellern und Geodaten. Ergebnisse: Von den eingereichten Kettensägeketten wurden 77 % (*n* = 493) ausgemustert, bevor ihre Funktionsdauer erschöpft war. Die durchschnittliche Anzahl der zusätzlichen Schärfungen, die die Ketten hätten durchführen können, betrug 4,54 (σ = 2,22). Nach dem Wirtschaftsmodell waren die Kosten für den Kauf neuer Ketten 3,64 bis 4,96 Mal höher als die Kosten für das Schärfen der Ketten im eigenen Haus. Die wirtschaftlichen Kosten für den Kauf einer neuen Kette waren im Allgemeinen 1,83 bis 3,74 Mal teurer als das Schärfen von Ketten im eigenen Haus. Schlussfolgerung: Diese Studie zeigt, dass die funktionelle Lebensdauer von Kettensägeketten häufig nicht ausgeschöpft wird und dass der Kauf von Ketten höhere buchhalterische und wirtschaftliche Kosten verursacht als das Schärfen von Ketten im eigenen Betrieb.

Resumen. Antecedentes: Las motosierras son una pieza primaria del equipo en arboricultura. El afilado de las cadenas de la motosierra es importante para la potencia de corte eficiente y continuo de la motosierra. Los análisis de los procedimientos de afilado de sierras de cadena pueden influir en la eficiencia y la sostenibilidad en la arboricultura. Investigaciones anteriores han examinado aspectos mecánicos y variabilidad de las cadenas de motosierras; sin embargo, existe una brecha de conocimientos con respecto a los métodos de afilado relacionados con la eficiencia operativa. Métodos: cadenas de motosierras retiradas del servicio operativo fueron presentadas por 132 equipos de arboricultura de 47 compañías durante un período de 6 meses. El equipo de investigación revisó 640 cadenas de motosierras para determinar si se había agotado la vida útil de las cadenas de motosierras. Si la vida funcional no se agotaba, se documentaba la vida funcional restante de la cadena. Para analizar el costo contable y el costo económico del afilado frente a la compra de nuevas cadenas de sierras de cadena, creamos un modelo económico con variables de los fabricantes de cadenas de sierras de cadena y datos geoespaciales. Resultados: de las cadenas de motosierras presentadas, el 77% (*n* = 493) fueron retiradas antes de agotar su vida funcional. El número medio de veces adicionales que las cadenas podrían haberse afilado fue de 4,54 veces más (σ = 2,22). Según el modelo económico, los costos contables de la compra de nuevas cadenas fueron de 3,64 a 4,96 veces más caros que el afilado interno de cadenas. El costo económico de comprar una nueva cadena fue generalmente de 1,83 a 3,74 veces más caro que el afilado de cadenas internamente. Conclusión: Este estudio demuestra que la vida útil funcional de las cadenas de motosierras con frecuencia no se agota y que las cadenas nuevas tienen mayores costos contables y económicos que el afilado de cadenas internamente.