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Development of Web-Based Rubber Tree Management System on Girth Growth Performance for Plantation Officer

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ABSTRACT

This study focuses on the development of a web-based information system for rubber plantation officers, including organizations such as RISDA, FELCRA, and smallholders. The study aims to address the limitations of conventional data collection methods and enhance overall plantation management efficiency. The study encompasses the identification of the current traditional method system, the design and implementation of the web-based system, and an evaluation of its effectiveness. Through a comprehensive literature review, the significance of this study in modernizing data collection practices in rubber plantations is established. The web-based system offers benefits such as improved data collection efficiency, enhanced data integrity, real-time data accessibility, and data-driven decision-making. The study concludes by recommending the adoption of the system, training for users, continuous improvement, collaboration, and expanding implementation to more plantations. This study contributes to streamlining rubber plantation management processes, fostering transparency, and promoting sustainable practices.

Keywords:
Girth growth; rubber tree; management system; plantation officer; girth performance

1. Introduction

The Malaysian authorities have introduced numerous policies aimed at bolstering the agricultural industry, with a special focus on assisting small-scale farmers. Furthermore, the government has actively extended financial assistance, subsidies, and training to help smallholder farmers cultivate cash crops like rubber [1]. The need for rubber is projected to stay robust in the coming period since rubber products continue to be highly pertinent and sought after for various specialized uses [2].

Hevea brasiliensis considered as valuable commodity crop [3], being cultured globally for production of natural rubber [4]. This species considered most effective producer of rubber compared the other ten identified Hevea spp. [5]. It is grown mostly for latex production, while its

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wood is considered as a secondary product [6]. In Malaysian rubber production, the types of harvest are divided into two which are latex and cup-lump [1]. The economic importance of the rubber tree has been recognized globally due to its high-quality latex [7]. The income from rubber latex exports is essential to the economic growth of these nations and provides for the smallholder farmers and rural communities who cultivate rubber.

The latex production can be used in several different sectors and applications including transportation, national defense, [8] and medical treatment [9] such as hoses, tyres, belts, gloves and other rubber products. The natural rubber is main ingredient due to its special qualities including robustness, high elasticity, and low heat buildup. It is crucial for promising vehicle safety, performance, and fuel efficacy.

This study focusing on the development of a Web-based Rubber Tree Management System for rubber tree plantation officers. With a specific focus on esteemed organizations like RISDA, FELCRA, and smallholders, this study seeks to develop data collection and enhance overall plantation management efficiency.

Nowadays, technological innovation has become a cornerstone for optimizing processes and achieving sustainability. This study focusing on the development of a web-based system that promises to improve current existing problems specifically for rubber tree girth management system. By implementing the proposed system, it can help plantation officers to collect data more efficiently and accurately, thus empowering them to make informed decisions that drive enhanced productivity and resource management.

2. Literature Review

Currently the main material streams from rubber tree that are considered having (economical) importance, namely wood and latex [6]. The main economically used fraction today is the latex of the rubber tree, which may be processed into a variety of rubber goods [10]. Due to its hypoallergenic qualities and superior barrier performance, rubber latex is also utilized in the production of a variety of medical products, including surgical masks, and elastic bandages, medical gloves [7], create rubber seals, gaskets, conveyor belts, adhesives, and coatings, create concrete additives, waterproofing solutions, and long-lasting coatings for walls and roofs, production of sporting products including gloves, balloons, and athletic footwear. Additionally, its main application is in the production of an elastomeric-based passive engine mounting [11].

A rubber tree is generally tapped using a manual tapping using knife [12], which also known as Jebong in Malaysia [13]. The tapping of rubber trees starts within the fifth to the seventh year after planting [14]. The age of 6 years after planting seems to be the best period to start tapping rubber trees, because it is a good benchmark of physiological maturity [15, 16].

The maximum latex yield is reached for trees between 15 and 22 years old, after which the yield decreases [*10*]. Hence, the girth growth of the rubber tree considered as important indicator of the maturity of the tree, on which the harvesting of latex is based [17]. It is used to ensure the tree is ready to be tapped, and producing latex at the optimum level. Hence, it is important for officers to know the trunk girth of rubber tree to monitor the growth stages. The officer then can decide to apply fertilizers and latex booster if needed based on the data.

However, as implemented in most plantations in Malaysia, the rubber plantation officer needs to measure the girth of rubber tree monthly in order to determine the growth performance of the particular rubber tree. As reported in [18], the trunk girth at 170cm above the ground was measured every month to estimate girth increment (GI) per month to gain the growth performance. Basically, the officers are required to write the data on a piece of paper during field visits. The collected data is then passed to the manager for an analysis purpose. The current technique used is similar to Indonesia where there are done manually and independently by survey workers [19].

The current techniques by using measuring tapes, which can be labor-intensive, time-consuming [13] and subject to measurement errors. Besides, it is hard for officers to keep track of the rubber trees growth and the recorded data can be easily manipulated due to delay. Therefore, solutions that can automate or partially automate the girth measurement procedure are needed to improve efficiency. An effective of indexing techniques are presently gaining consideration and can be considered importance for an analysis purpose [16].

Thus, in order to investigate forested land covers, a system that can capture and monitor datasets systematically over wide areas are needed [20]. However, there is a lack of system management for this rubber plantation. Thus, this system is needed to support rubber tree management planning which focusing on measuring tree diameter and mapping administered on an ongoing basis [19].

3. Methodology

This study implements ADDIE model that comprises of five phases namely (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. One of the most widely used models for instructional design is the ADDIE model, which serves as a manual for creating successful designs. [21]. Each phase has its own tasks and pre-process involved as in Figure 1. The ADDIE Model is an iterative instructional design approach where the researcher may go back to any earlier step depending on the findings of the formative evaluation of each phrase.

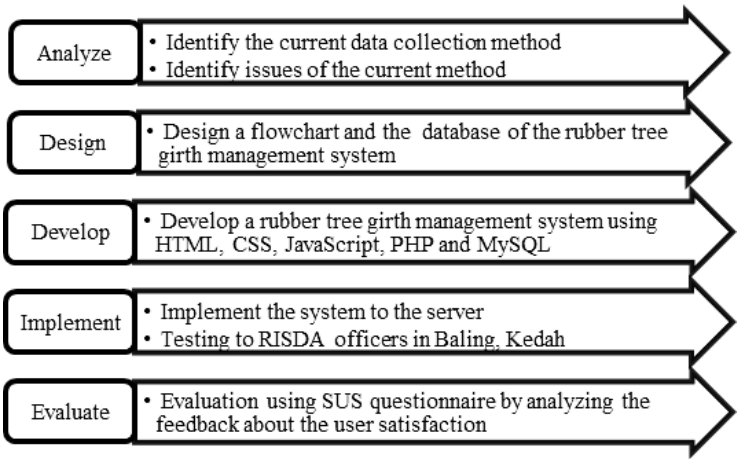


Fig. 1. ADDIE model

3.1 Analysis Phase

This phase focus on identifying the current data collection method and identifying the issues that can occur using the traditional method. In order to obtain data for analysis and decision-making, data collection techniques are essential. The data was collected through field observations and oral interviews of rubber plantations officers and smallholder at Rubber Industry Smallholders Development Authority (RISDA) in Baling, Kedah. Oral interviews were employed to gather general data from the management. Designing a unique identification number of respectively rubber tree was an importance in the process of validation of the data [14]. The sample of the collected data shown in the Table 1.

The traditional data gathering techniques, such paper surveys or phone interviews, can be vulnerable to several problems and mistakes. The manual data entry, first and foremost, increases the possibility of human error. Inaccurate data might come from transcription errors, omissions, or misinterpretations when replies are transferred from paper to digital format. In the same way, misunderstandings or miscommunications between the interviewer and the responder during phone interviews can skew results or create bias.

Table 1
Sample of data

Tree number/time period	1st month	6th month	12th month	18th month	24th month
A1	17	21	26	33	36
A2	18	21	26	31	38
A3	17	22	26	32	38
A4	19	24	26	31	35
A5	19	25	26	31	36
A6	18	25	27	32	37
A7	20	24	28	33	37
B1	18	23	27	32	36
B2	16	23	27	32	37
B3	16	22	27	33	35
B4	18	23	26	32	37
B5	17	23	27	34	37
B6	18	24	27	30	38
B7	20	24	26	33	35
C1	17	24	28	32	37
C2	19	23	29	32	38
C3	18	21	28	31	37
C4	20	23	27	34	38
C5	18	21	28	33	38
C6	16	23	26	31	36
C7	17	22	27	31	38
…	…	…	…	…	…
n	n	n	n	n	n

Second, traditional approaches frequently have low response rates. Long surveys or interviews could make people hesitant to participate, which could lead to a biased sample that doesn't accurately reflect the target demographic. This may result in distorted perceptions and inaccurate judgements.

Traditional methods can sometimes be expensive and time-consuming. Paper surveys need a large amount of manual labour and financial resources to develop, print, distribute, and collect. Like in-person interviews, phone interviews can take a lot of time and may need a large team of interviewers. These characteristics restrict scalability and make it difficult to gather data from a wide range of people.

3.2 Design Phase

The flow and interactions of the user interface and user experience must be visually presented when creating a design storyboard for a website. The storyboard acts as a visual narrative or blueprint outlining the various displays, interfaces, and interactions that a user come across when navigating the website. Figure 2 show the flowchart of the system.

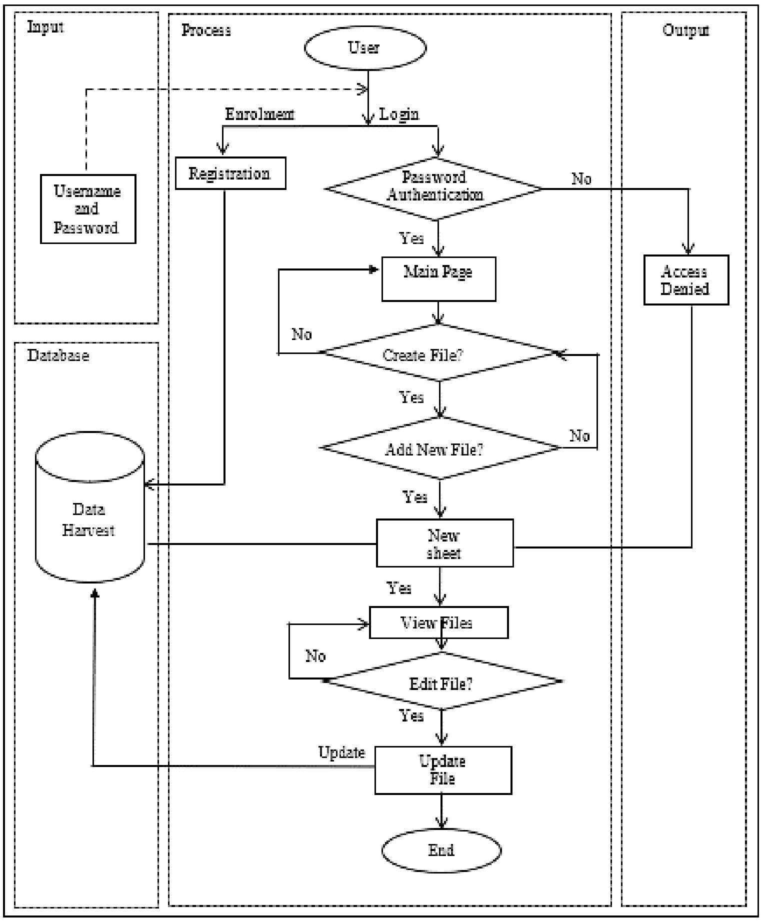
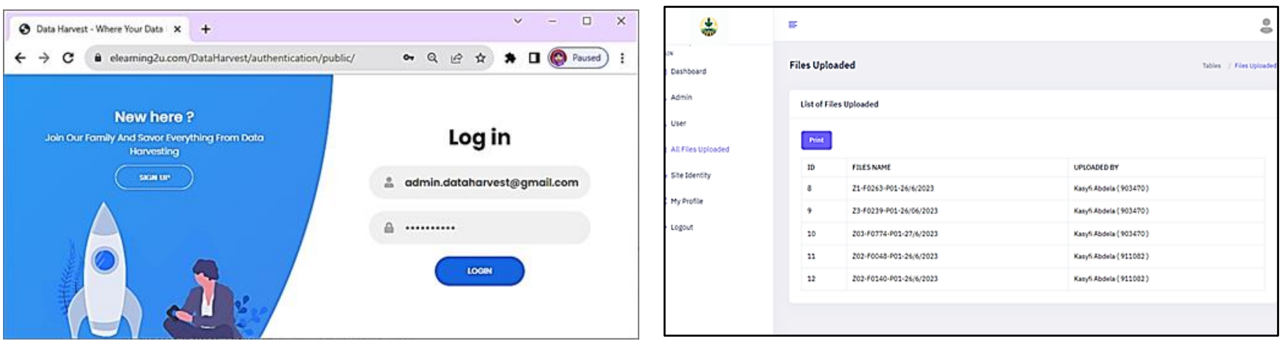


Fig. 2. Flowchart of rubber girth tree management system

3.3 Development Phase

A rubber girth tree management system is a web-based system using user-centre approach. The insights data was gathered from the initial interviews and surveys guide the creation of an intuitive and user-friendly interface to meet the needs of rubber plantation officers and workers. The system is developed using HTML, CSS and JavaScript for the frontend (Interface), PHP for backend (Server Processing) and MySQL for the database and also creating a subdomain for the website so users can access more easily in the internet. The development process is iterative, involving continuous feedback from potential users to refine the system's usability and functionality. This system can be access by the url, http://elearning2u.com/DataHarvest/ as shown in the Figure 3.



(a) (b)

Fig. 3 Rubber girth tree management system (a) Main page (b) Files uploaded page

3.4 Implementation Phase

Implementation phase refers to the process of conducting the website system by the researcher which intended to get the location and the target respondent. The test is conducted to make sure that this system achieves the objectives of the study. It was conducted with some of the RISDA officers in Baling, Kedah and some of the smallholders to test the system.

3.5 Evaluation Phase

The final step is to analyse the effectiveness of this system using System Usability Scale (SUS). This analysis includes assessing factors of user satisfaction. It consists of a 10-item questionnaire with five response options for respondents; from strongly disagree (scale 1), disagree (scale 2), uncertain (scale 3), agree (scale 4) and strongly agree (scale 5). Then, a selected number of rubber plantations are chosen randomly for the testing of the system. Plantation officers and workers actively engage with the system during this phase, providing valuable feedback on its usability. The collected data are subjected to statistical analysis to quantify the system's impact on enhancing data collection efficiency and accuracy.

4. Results

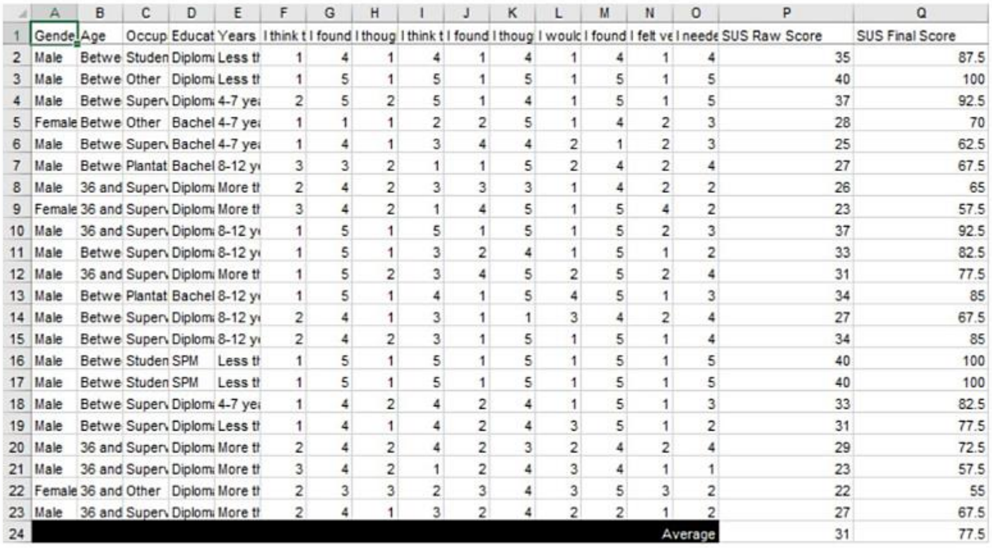
The initial scores of 0-40 are changed to 0-100 based on the interpreting scoring. To do this, the respondent's scores for each question are changed to a new number, summed together, and then multiplied by 2.5. Even though the scores range from 0 to 100, they should only be viewed in terms of their percentile ranking since they are not percentages. Table 2 shows the SUS questionnaire item.

Table 2
The SUS questionnaire item

No.	Item
1.	I think that I would like to use this system frequently.
2.	I found the system unnecessarily complex.
3.	I thought the system was easy to use.
4.	I think that I would need the support of a technical person to be able to use this system.
5.	I found the various functions in this system were well integrated.
6.	I thought there was too much inconsistency in this system.
7.	I would imagine that most people would learn to use this system very quickly.
8.	I found the system very cumbersome to use.
9.	I felt very confident using the system.
10.	I needed to learn a lot of things before I could get going with this system.

In SUS score, the result more than 68 can be considered above the average, and others is considered below average. Nevertheless, the results are best interpreted after "normalizing" the scores to provide a percentile rating. The user feedback indicated a high level of satisfaction with the system's ease of use and intuitive interface. Officers reported that the system streamlined data management, reduced administrative burden, and enhanced overall efficiency in plantation operations.

Based on the Figure 4., it shows the result of SUS score of this study which about 77.5. This result considered as above the average. This indicates that the respondents are satisfied with the usability of this system from all the item including the functions, complexness of the system and also user friendliness.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Gende	Age	Occup	Educat	Years	I think t	I found	I thoug	I think t	I found	I thoug	I woulc	I found	I felt ve	I neede	SUS Raw Score	SUS Final Score
2	Male	Betwe	Studen	Diplom	Less tl	1	4	1	4	1	4	1	4	1	4	35	87.5
3	Male	Betwe	Other	Diplom	Less tl	1	5	1	5	1	5	1	5	1	5	40	100
4	Male	Betwe	Superv	Diplom	4-7 yea	2	5	2	5	1	4	1	5	1	5	37	92.5
5	Female	Betwe	Other	Bachel	4-7 yea	1	1	1	2	2	5	1	4	2	3	28	70
6	Male	Betwe	Superv	Bachel	4-7 yea	1	4	1	3	4	4	2	1	2	3	25	62.5
7	Male	Betwe	Plantat	Bachel	8-12 y	3	3	2	1	1	5	2	4	2	4	27	67.5
8	Male	36 and	Superv	Diplom	More tl	2	4	2	3	3	3	1	4	2	2	26	65
9	Female	36 and	Superv	Diplom	More tl	3	4	2	1	4	5	1	5	4	2	23	57.5
10	Male	36 and	Superv	Diplom	8-12 y	1	5	1	5	1	5	1	5	2	3	37	92.5
11	Male	Betwe	Superv	Diplom	8-12 y	1	5	1	3	2	4	1	5	1	2	33	82.5
12	Male	36 and	Superv	Diplom	More tl	1	5	2	3	4	5	2	5	2	4	31	77.5
13	Male	Betwe	Plantat	Bachel	8-12 y	1	5	1	4	1	5	4	5	1	3	34	85
14	Male	Betwe	Superv	Diplom	8-12 y	2	4	1	3	1	1	3	4	2	4	27	67.5
15	Male	Betwe	Superv	Diplom	8-12 y	2	4	2	3	1	5	1	5	1	4	34	85
16	Male	Betwe	Studen	SPM	Less tl	1	5	1	5	1	5	1	5	1	5	40	100
17	Male	Betwe	Studen	SPM	Less tl	1	5	1	5	1	5	1	5	1	5	40	100
18	Male	Betwe	Superv	Diplom	4-7 yea	1	4	2	4	2	4	1	5	1	3	33	82.5
19	Male	Betwe	Superv	Diplom	Less tl	1	4	1	4	2	4	3	5	1	2	31	77.5
20	Male	36 and	Superv	Diplom	More tl	2	4	2	4	2	3	2	4	2	4	29	72.5
21	Male	36 and	Superv	Diplom	More tl	3	4	2	1	2	4	3	4	1	1	23	57.5
22	Female	36 and	Other	Diplom	More tl	2	3	3	2	3	4	3	5	3	2	22	55
23	Male	36 and	Superv	Diplom	More tl	2	4	1	3	2	4	2	2	1	2	27	67.5
24															Average	31	77.5

Fig. 4. Result of SUS score

5. Conclusion

In conclusion, the adoption of this system offers a leap forward in data collection efficiency, accuracy, and management. The reduction of data manipulation risks and real-time accessibility to critical information enable officers to make timely decisions for optimized resource allocation and management. The positive feedback from users emphasizes the system's user-friendly nature and potential to enhance the overall productivity of rubber plantations. The findings emphasize the need for collaboration among organizations like RISDA, FELCRA, and smallholders to embrace and implement this technological solution.

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References

[1] Ali, Muhammad Fadzli, Md Ali Akber, Carl Smith, and Ammar Abdul Aziz. "The dynamics of rubber production in Malaysia: Potential impacts, challenges and proposed interventions." *Forest Policy and Economics* 127 (2021): 102449. https://doi.org/10.1016/j.forpol.2021.102449

[2] Leong, Seng-Yi, Siang-Yin Lee, Thiam-Young Koh, and Desmond Teck-Chye Ang. "4R of rubber waste management: current and outlook." *Journal of Material Cycles and Waste Management* 25, no. 1 (2023): 37-51. https://doi.org/10.1007/s10163-022-01554-y

[3] Mazlan, Safwan, Noraini Md JAAFAR, Aswad Wahab, Heraa Rajandas, and Dzarifah Zulperi. "Major diseases of rubber (Hevea brasiliensis) in Malaysia." *Pertanika Journal of Scholarly Research Reviews* 5, no. 2 (2019).

[4] Chima, Uzoma Darlington, Dong-ling Qi, Zhi-xiang Wu, Guo-yu Lan, and Li Chen. "Diversity, interspecific interaction and abundance of undergrowth in monocultures and integrated systems of natural rubber plantation in Danzhou, southern China." (2022): 75-89. https://doi.org/10.7747/JFES.2022.38.2.75

[5] Masson, Aurélien, and Olivier Monteuuis. "Rubber tree clonal plantations: grafted vs self-rooted plant material." *Bois & Forets Des Tropiques* 332 (2017): 57-68.

[6] Tangonyire, Damian Felladam. "Assessing the growth performance of two different Hevea Brasiliensis Clones (Irca 41 And Gt 1) in the Guinea Savanna soil in the Northern Region of Ghana." *Malays. J. Sustain. Agric* 3 (2019): 46-55. http://doi.org/10.26480/mjsa.02.2019.46.55

[7] Trisasongko, Bambang H., Dyah R. Panuju, Amy L. Griffin, and David J. Paull. "Fully polarimetric L-band synthetic aperture radar for the estimation of tree girth as a representative of stand productivity in rubber plantations." *Geographies* 2, no. 2 (2022): 173-185. https://doi.org/10.3390/geographies2020012

[8] Mikhaylov, IAa, KVa Sukhareva, Yu O. Andriasyan, AA ab Popov, and NVa Vorontsov. "Mechanochemical modification of natural rubber." In *AIP Conference Proceedings*, vol. 1783, no. 1. AIP Publishing, 2016. https://doi.org/10.1063/1.4966446

[9] Zhang, Chunlong, Liyun Yong, Ying Chen, Shunlu Zhang, Luzhen Ge, Song Wang, and Wei Li. "A rubber-tapping robot forest navigation and information collection system based on 2D LiDAR and a gyroscope." *Sensors* 19, no. 9 (2019): 2136. https://doi.org/10.3390/s19092136

[10] Widyarani, Stef CW Coulen, Johan PM Sanders, and Marieke E. Bruins. "Valorisation of proteins from rubber tree." *Waste and Biomass Valorization* 8 (2017): 1027-1041. https://doi.org/10.1007/s12649-016-9688-9

[11] Abd Ghani, Anis Aqilah, Noraiham Mohamad, Jeefferie Abd Razak, Qumrul Ahsan, Chang Siang Yee, Muhammad Afiq Ani, Ming Ming Teng, and Anwar Ul-Hamid. "Optimization of hot press parameters to maximize the physical and mechanical properties of natural rubber composites for Elastomeric Mount." *Malaysian Journal on Composites Science and Manufacturing* 1, no. 1 (2020): 27-37. https://doi.org/10.37934/mjcsm.1.1.2737

[12] Yang, Hui, Zejin Sun, Junxiao Liu, Zhifu Zhang, and Xirui Zhang. "The development of rubber tapping machines in intelligent agriculture: A review." *Applied Sciences* 12, no. 18 (2022): 9304. https://doi.org/10.3390/app12189304

[13] Kamil, Muhammad Faez Md, Wan Nurshazwani Wan Zakaria, Mohd Razali Md Tomari, Tee Kian Sek, and Nurfarina Zainal. "Design of automated rubber tapping mechanism." In *IOP Conference Series: Materials Science and Engineering*, vol. 917, no. 1, p. 012016. IOP Publishing, 2020. https://doi.org/10.1088/1757-899X/917/1/012016

[14] Talosig, Eduardson E., Cerenio Adriatico, and Fil Ryan P. Yap. "Profiling and Geo-Tagging of Rubber Tree Plantation through Geographic Information System." *Open Access Library Journal* 6, no. 7 (2019): 1-14. https://doi.org/10.4236/oalib.1105460

[15] Obouayeba, Samuel, Soumahin Francis Eric, Kouassi Kan Modeste, Coulibaly Lacina Fanlégué, K. F. Okoma, Angelo Evariste Badou N'guessan, Kouamé Christophe, and Sévérin Aké. "Influence of age and girth at opening on rubber yield, biochemical and tapping panel dryness parameters of Hevea brasiliensis in determining tapping norms." *Int. J. Biosci* 2 (2012): 1-18.

[16] Nattharom, Narun, Saowalak Roongtawanreongsri, and Sara Bumrungsri. "Growth prediction for rubber tree and intercropped forest trees to facilitate environmental services valuation in South Thailand." *Biodiversitas Journal of Biological Diversity* 21, no. 5 (2020). https://doi.org/10.13057/biodiv/d210528

[17] Bhusudsawang, Gunlayarat, Ratchanee Rattanawong, Thitaporn Phumichai, Wirulda Pootakham, Sithichoke Tangphatsornruang, and Kittipat Ukoskit. "Identification of candidate gene-based markers for girth growth in rubber trees." *Plants* 10, no. 7 (2021): 1440. https://doi.org/10.3390/plants10071440

[18] Nhean, Sophea, Supat Isarangkool Na Ayutthaya, Rachanee Rathanawong, and Frederic C. Do. "Immature growth performance of three important rubber tree ('Hevae brasiliensis') clones in a drought-prone area." *Australian Journal of Crop Science* 14, no. 3 (2020): 469-474. https://doi.org/10.21475/ajcs.20.14.03.p2029

[19] Putra, Bayu Taruna Widjaja, Nadira Janna Ramadhani, Dedy Wirawan Soedibyo, Bambang Marhaenanto, Indarto Indarto, and Yualianto Yualianto. "The use of computer vision to estimate tree diameter and circumference in homogeneous and production forests using a non-contact method." *Forest Science and Technology* 17, no. 1 (2021): 32-38. https://doi.org/10.1080/21580103.2021.1873866

[20] Samoladas, Dimitrios, Christos Karras, Aristeidis Karras, Leonidas Theodorakopoulos, and Spyros Sioutas. "Tree data structures and efficient indexing techniques for big data management: A comprehensive study." In *Proceedings of the 26th Pan-Hellenic Conference on Informatics*, pp. 123-132. 2022. https://doi.org/10.1145/3575879.3575977

[21] Aldoobie, Nada. "ADDIE model." *American international journal of contemporary research* 5, no. 6 (2015): 68-72.