



Knowledge and Technologies for Effective Wood Procurement

T4E Bucking App – A mobile device based application for value-optimized motor-manual bucking

Manual

Version 1.2 – May 2019

Lead beneficiary: BOKU

Main contact: Gernot Erber; gernot.erber@boku.ac.at

Contributors Michael Viertbauer, Latschbacher

Viktor Schildberger, Latschbacher

Project acronym: TECH4EFFECT

Project Number: 720757

Start date of project: 01.10.2016

Project duration: Oct. 2016 – Sept 2020



This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

Table of Contents

1	Summary.....	1
2	How to work with the T4E Bucking App	2
3	Manual (Version 1.2 - May 2019).....	4
3.1	T4E Bucking App availability.....	4
3.2	Settings	4
3.2.1	App menu	4
3.2.2	Definition of permissible assortments.....	5
3.2.3	Operation definition	6
3.2.4	Operation details.....	7
3.3	Bucking.....	7
3.3.1	Required equipment.....	8
3.3.2	Measurements and data input before felling	8
3.3.3	Measurements, assessment and data input after felling	8
3.3.4	Optimized bucking scheme.....	9
3.3.5	Customized bucking scheme	10
3.3.6	Bucking.....	11
3.3.7	Alteration of bucking scheme during bucking.....	11
3.4	Statistics	12
3.4.1	Tree by tree and assortment statistics.....	12
3.4.2	Statistics export	13

1 Summary

When timber is harvested, trees are felled and cut ("bucked") into pieces (so called "assortments") of different length. Pricing of the assortments depends on their length, diameter class and quality and is given in € per m³, which is then multiplied with the respective volume. In motor-manual felling and bucking operations, the chainsaw operator has to determine which assortments to cut from a given tree. By separating the tree into the most suitable combination of assortments, the highest value can be gained from a given tree. In contrast to fully mechanized harvesting operations, chainsaw operators are at the moment not aided by computers when taking this value-defining decision. Further, they are lacking a proper performance documentation in the form of an assortment list and aggregated volumes per assortment, species, quality, length or diameter class.





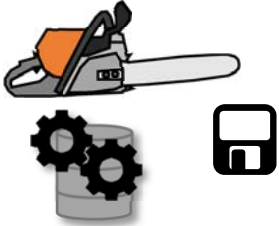

The T4E Bucking App is an application for Android OS mobile devices, which aims to close this gap. With the T4E Bucking App, a value-optimized bucking scheme can be determined for a given tree from tree and contractual parameters entered by the user, thereby assisting the chainsaw operator in this critical decision. Further, the T4E Bucking App provides after-operation statistics, which can be utilized for documentation and planning purposes.

However, the T4E Bucking App does not aim to replace, but to assist the human brain when taking the bucking decision. While on the one hand enabling fully computer-aided operation, the user is on the other hand able to select a customized bucking scheme, which can be compared to the value-optimized scheme. This functionality aims at providing the user with a training option, which can be employed for both personal and institutionalized education and training purposes. This functionality is of further use when defects that go unnoticed during the visual pre-bucking inspection require to alter the original bucking scheme.

The T4E Bucking App's target groups are (1) only occasionally bucking users ("farmer"), (2) users in education and training (forestry schools and training centres) and (3) professional chainsaw operators. The intention of the app is to not make the user depending on it to take the bucking decision, but to aid the decision as long as the user is not skilled enough to take the decision on his own. Occasionally bucking users are envisioned to profit from the app by assisted training on the job and increased value recovery due to a well-founded decision. In education and training, the app can be used as a tool to compare trainees' ideas of the most suitable bucking scheme to each other or during personal training to the suggested value-optimized scheme. Professional users can benefit from the T4E Bucking App in terms of work documentation and as calibration tool, where every now and then the user decision is compared against the suggested solution.

2 How to work with the T4E Bucking App

The T4E Bucking App can be operated in six steps as displayed in Fig 1:

Step 1	Before any operation, the permissible assortments according to the user's contract must be defined. This is done on a computer via a Microsoft-Excel spreadsheet solution. From the spreadsheet, a definition export file is generated and transferred to the mobile device, on which the T4E Bucking App is operated. Multiple definitions can be created. In the app, a new operation is created and operational parameters (e.g. topping diameter, permissible assortment definition, ...) are defined/selected. Multiple operations can be defined.	
Step 2	After selecting an operation, working with the T4E Bucking App in the forest can start. In a first step the tree species is assessed visually and the DBH is measured on the standing tree. Respective data is entered in the app's Tree parameter form.	
Step 3	After felling of the tree, stump height, trunk and crown length are measured and entered in the app's Tree parameter form.	
Step 4	Then the quality allocation along the stem in terms of quality and length of the single quality sections have to be specified and entered in the app's Quality allocation form.	
Step 5	After all data is entered, bucking optimization is carried out and the user receives a value-optimized bucking scheme according to his assortment definition and tree data. If she / he wishes to customized a scheme, a respective option including comparison to the suggested scheme is available. From here the user proceeds to a visualization of the chosen bucking scheme and the tree can be bucked accordingly. During this step, if necessary, the scheme can be customized again, e.g. because of defects before not recognizable. After completing bucking, tree and assortment data is saved.	
Step 6	After an operation, the user can access tree by tree and cumulated assortment statistics and export data to other electronic devices.	

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

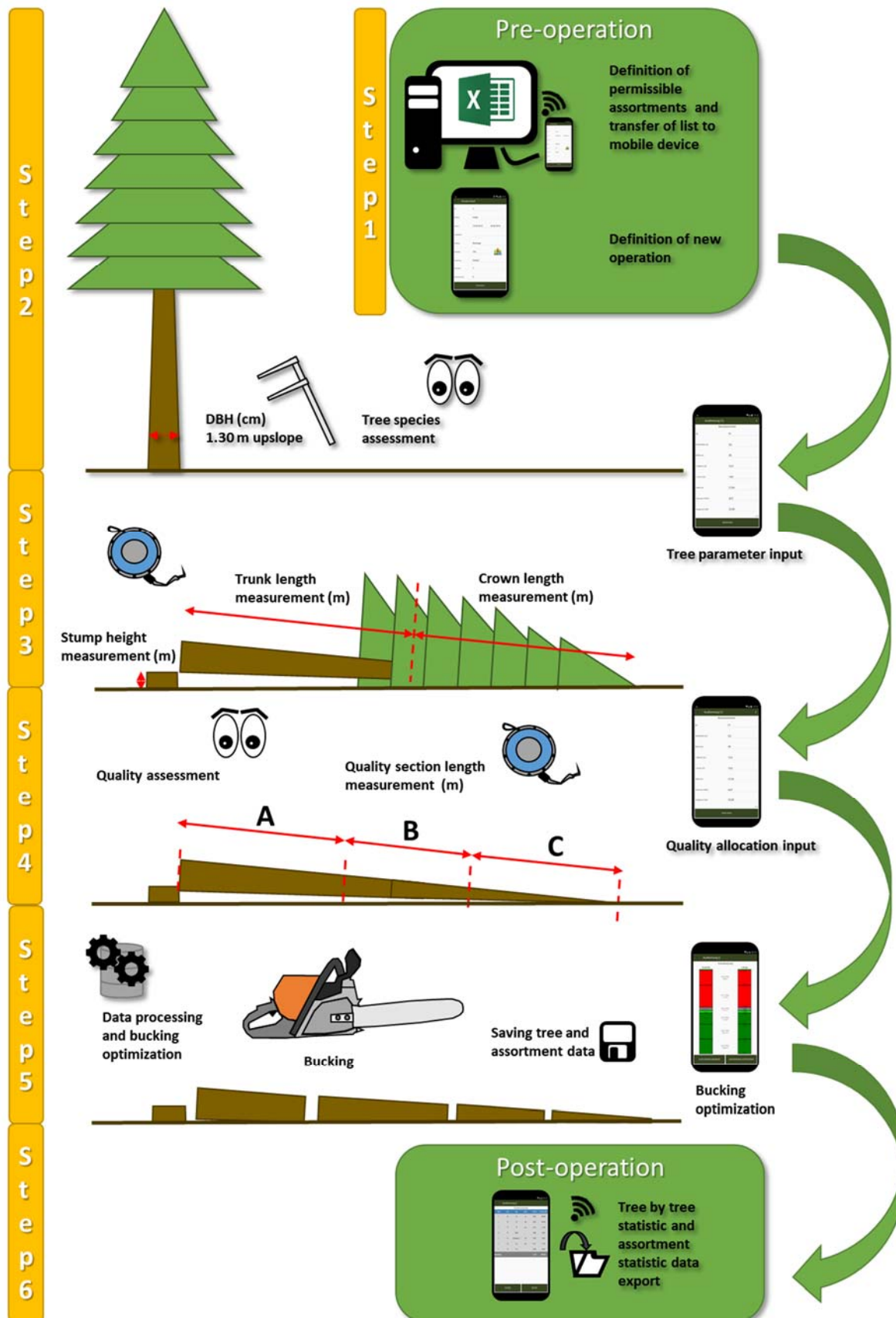


Fig 1: Procedure of working with the T4E Bucking App.

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

3 Manual (Version 1.2 - May 2019)

3.1 T4E Bucking App availability

The T4E Bucking App is as yet exclusively available for Android OS mobile devices from the Google Play Store via this link: <https://play.google.com/store/apps/details?id=com.latschbacher.buckingapp>

3.2 Settings

3.2.1 App menu

To open the app menu (Figure 1), press the menu button at the top left of the app on the **Operation Screen**. From the app menu, the **Operation Screen** can be accessed via **"Operations"**. The operating language can be switched between German and English in the apps menu via **"Settings"**. Open the **"Settings"** menu and select the desired language. Press the **"Save"** button on the bottom to save the language settings. Information about the app can be found in the **"About"** section. To close the app, use the **"Exit"** button.

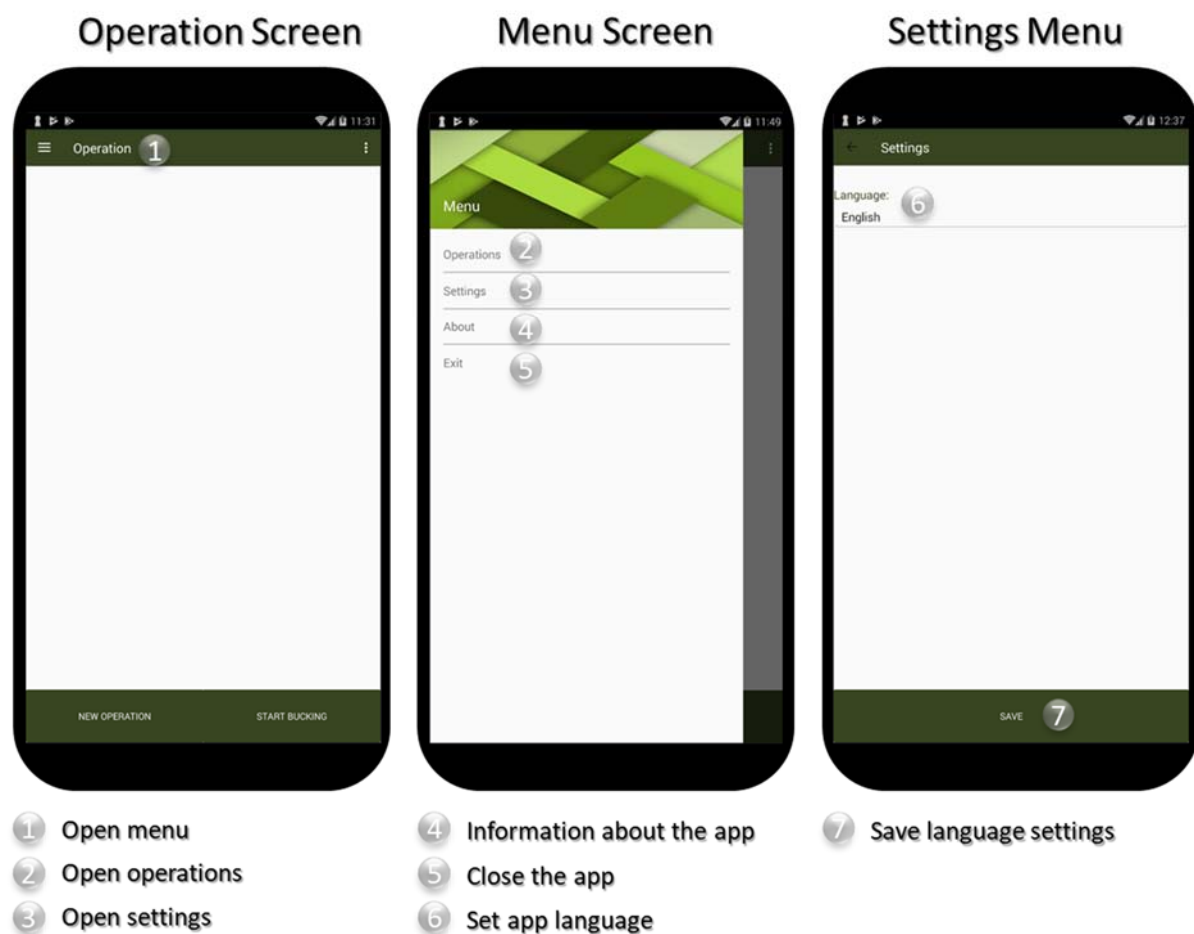


Figure 1: Functionality of the app menu: access of operation screen, language settings, app information and closing of the app.

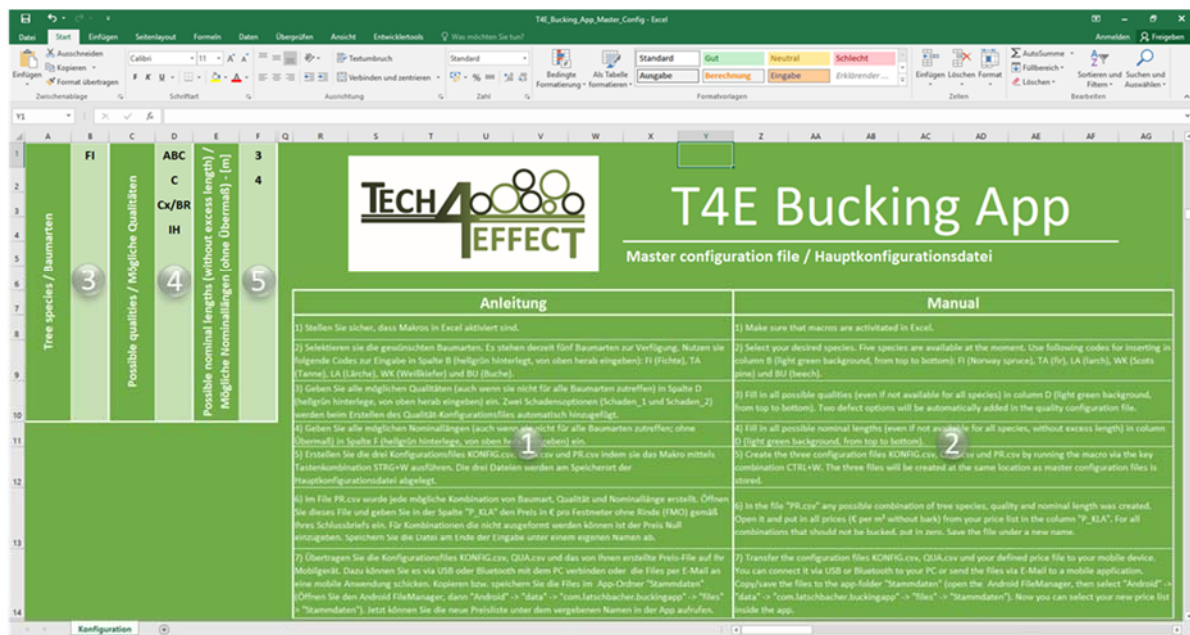
This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

3.2.2 Definition of permissible assortments

Before operating the T4E Bucking App, the user has to define (1) the permissible assortments and (2) their respective prices. Based on the user's contract, any permissible combination of (1) **species**, (2) **nominal length**, (3) **diameter class**, (4) **quality** and (5) **respective price per m³ without bark** has to be defined. E.g. a fully defined assortment could be Norway spruce of 4 m nominal length, a diameter class 3a, a quality of B (second highest) and a price of 90 € m⁻³.

Definition of the permissible assortments is facilitated by a **Master configuration file**, which is provided in form of a Microsoft Excel spreadsheet solution with macros (T4E_Bucking_App_Master_Config.xlsm). The spreadsheet can be copied from the app's "**Stammdaten**"-folder. The folder can be accessed on the mobile device via the **Android FileManager** ("**Android**" -> "**data**" -> "**com.latschbacher.buckingapp**" -> "**files**" -> "**Stammdaten**"). Transfer the file to your PC via USB, Bluetooth, mail or other means of data transmission.

To define the permissible assortments, open the **Master configuration file** (Figure 2) in Excel (T4E_Bucking_App_Master_Config.xlsm). Make sure that **macros** are **activated** in Excel. First select your desired **species**. Five species are available at the moment. Use following codes for inserting in **column B** (light green background, from top to bottom): FI (Norway spruce), TA (fir), LA (larch), WK (Scots pine) und BU (beech). Then fill in all possible **qualities** (even if not available for all species) in **column D** (light green background, from top to bottom). Two defect options will be automatically added in the **quality configuration file**. Finally fill in all possible **nominal lengths** (even if not available for all species, without excess length) in **column E** (light green background, from top to bottom).



1 German language manual

2 English language manual

3 Species definition

4 Quality definition

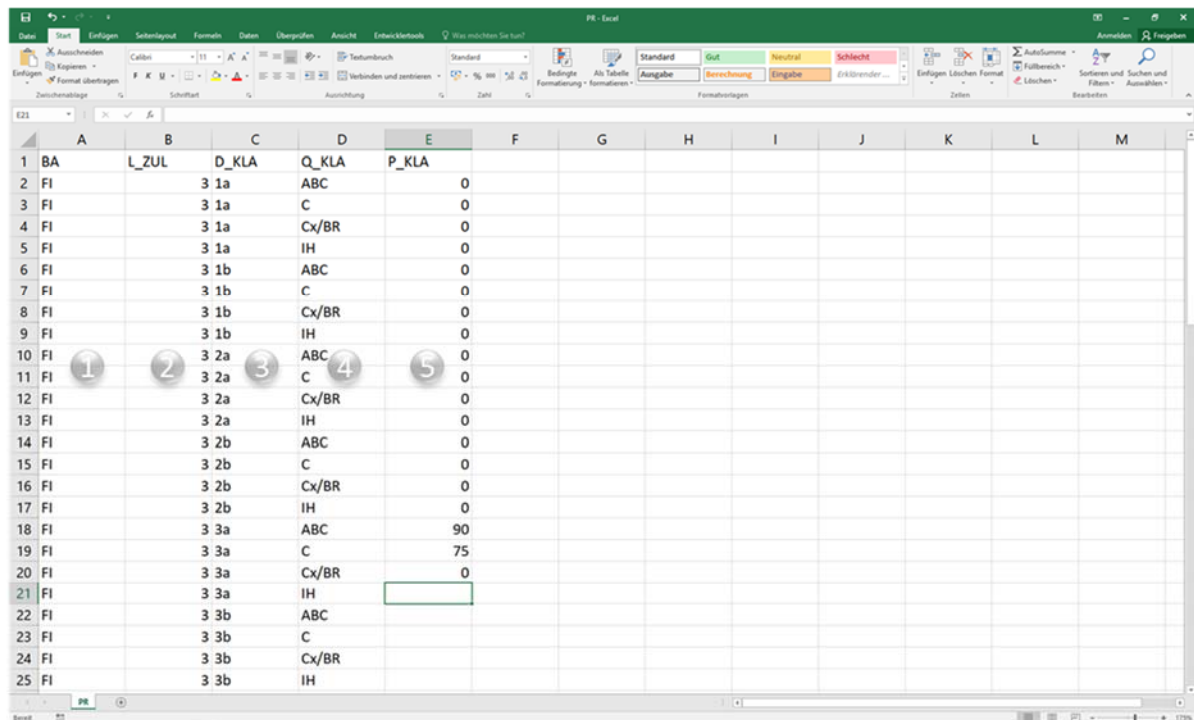
5 Nominal length definition

Figure 2: Functionality of the Master configuration file, which is used to define the permissible assortment.

Create the three configuration files **KONFIG.csv**, **QUA.csv** and **PR.csv** by running the **macro** via the key combination **CTRL+W**. The three files will be created at the same location as the one where the **Master**

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

configuration file is stored. Open the file **PR.csv** (Figure 3). In this file any possible combination of tree species, quality and nominal length was created. Put in all prices (€ per m³ without bark) from your price list in the **column "P_KLA"**. For all combinations that should not be bucked, put in zero. **Save** the file **under a new name**. Make sure this **name starts** with **"PR"**, so the file is identified as a price list by the app.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	BA	L_ZUL	D_KLA	Q_KLA	P_KLA								
2	FI		3 1a	ABC	0								
3	FI		3 1a	C	0								
4	FI		3 1a	Cx/BR	0								
5	FI		3 1a	IH	0								
6	FI		3 1b	ABC	0								
7	FI		3 1b	C	0								
8	FI		3 1b	Cx/BR	0								
9	FI		3 1b	IH	0								
10	FI	1	3 2a	ABC	4	5							
11	FI	2	3 2a	C	0								
12	FI		3 2a	Cx/BR	0								
13	FI		3 2a	IH	0								
14	FI		3 2b	ABC	0								
15	FI		3 2b	C	0								
16	FI		3 2b	Cx/BR	0								
17	FI		3 2b	IH	0								
18	FI		3 3a	ABC	90								
19	FI		3 3a	C	75								
20	FI		3 3a	Cx/BR	0								
21	FI		3 3a	IH									
22	FI		3 3b	ABC									
23	FI		3 3b	C									
24	FI		3 3b	Cx/BR									
25	FI		3 3b	IH									

- 1 Species column
- 2 Nominal length column
- 3 Diameter class column
- 4 Quality column
- 5 Price column

Figure 3: Functionality of the Price configuration file, which is used to define the prices of permissible assortments.

Transfer the configuration files **KONFIG.csv**, **QUA.csv** and your **defined price file in .csv-format** to your mobile device via USB, Bluetooth, mail or other means of data transmission. Copy/save the files to the app-folder "Stammdaten" (open the **Android FileManager**, then select **"Android"** -> **"data"** -> **"com.latschbacher.buckingapp"** -> **"files"** -> **"Stammdaten"**). Now you can select your new price list inside the app. Through assigning different names, multiple assortment definitions can be created and stored.

3.2.3 Operation definition

A new operation is created via the Button **"New operation"** on the bottom left of the **Operation Screen** (Figure 3). At least one operation is required to start the bucking scheme optimization. The **Operation Menu** is opened via the menu button on the top right of the Operations Screen. It allows to access detailed information on already created operations (**"Operation details"**) or delete operations (**"Delete operation"**). Further, tree by tree and assortment statistics can be accessed. Users can create multiple operations and switch between operations.

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

3.2.4 Operation details

In the **Operation details Menu** (Figure 4) operations are numbered subsequently (**No.**) and **operation start** (first tree bucked) and **end dates** (last tree bucked so far) are recorded and updated. Further, **geographical location** and **height above sea level** (mandatory) are either entered manually or can be retrieved from the mobile devices GPS-unit on-site. Further, additional information can be added (**operation name, user-specific information, stand designation, bucker's name**). Finally, the desired **price list** intended to use for this operation has to be selected from the dropdown menu. All input is saved via the **"Save"** button at the bottom.

The user can configure the **topping diameter**, which is otherwise set to a default of 7 cm. The excess length is defined according to the **Austrian timber trade guidelines**. These define the excess length as 1.0 % (coniferous species) and 1.5 % (broadleaf species) of the nominal length with a minimum of 6 cm, regardless of nominal length and species. In order to resemble reality more closely, a user specific, additional excess length, which is added to the excess length required by the Austrian timber trade guidelines, can be defined. This **user specific excess length** can be configured individually per operation. Further, 1 cm is added to each assortment for the **cutting slit**.

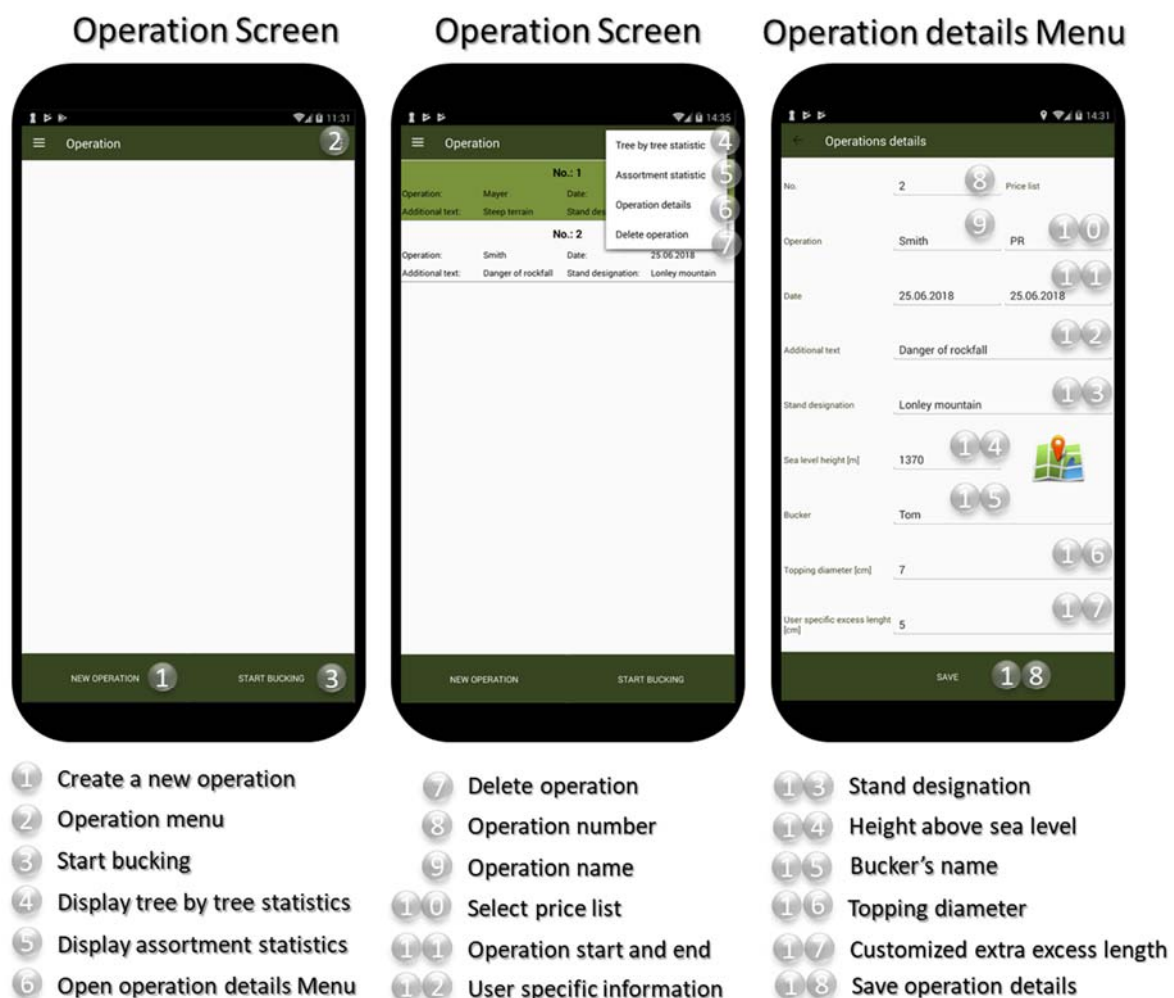


Figure 4: Functionality of Operation and Operation details Screen.

3.3 Bucking

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

3.3.1 Required equipment

Apart from a mobile device for operating the T4E Bucking App, having the T4E Bucking App installed and completed the steps described in 3.2, the user needs to be equipped with **means for measuring diameters and lengths**. For the first task, either a calliper, a girth measurement tape or, with some limitations, a measuring tape can be used. For length measurement a measuring or logger's measuring tape is required.

3.3.2 Measurements and data input before felling

By selecting an operation and pressing "**Start bucking**" on the bottom-left of the **Operation Screen** (Figure 4, the **Tree Parameter Screen** (Figure 5) opens and data for the first tree can be entered. Data input starts with selecting the **Tree Species** (SP) from the dropdown menu. German language abbreviations are used for the species and correspond to English language species names as displayed in Tab 1. The next input parameter is the **diameter at breast height** (DBH, cm rounded down to the next integer) which is measured on the standing tree at 1.30 m on the upslope side of the tree.

Tab 1: English language equivalents to German language species abbreviations.

Species abbreviation	FI	TA	LA	WK	BU
German language species name	Fichte	Tanne	Lärche	Kiefer	Buche
English language species name	Spruce	Fir	Larch	Pine	Beech

3.3.3 Measurements, assessment and data input after felling

After felling the tree, **stump height** (m) is measured on the upslope side of the tree. Then the **trunk length** (m) is measured from the felling cut to the crown base. The crown base is defined as the first branch whorl with at least one alive knot that is not followed by any branch whorl without at least one alive knot. Subsequently, the **crown length** (L, m) from the crown base to the crown tip is measured. Stump height, trunk and crown length measurements are put in the respective form fields on the **Tree Parameters Screen** (Figure 5). From these parameters, the **tree height** (m), the felled **tree's volume** in bark (m³) and **topping length** (m from felling cut) are calculated and displayed. Then the user proceeds to the **Quality Allocation Screen** (Figure 5) via the "**Save**" button.

Further, the user has to determine the **quality allocation** along the length of the tree and assign a start and end point for each quality. For the first quality section, starting from the felling cut, an end point is put in in the **End column** and a quality is selected from the **Quality column**. From the last **End column** value, the next **Start column** value is generated. To add further lines, "**New line**" is chosen from the top-right menu. This step is repeated till the tree length is reached. If the user encounters a section with a defect that shall not be included in the optimization, the quality "Defect" has to be selected and the respective start and end point has to be entered. To correct a line, "**Delete last line**" can be selected from the same menu. To proceed to the bucking optimization, the button "**Optimize scheme**" at the bottom has to be pressed.

Tree Parameters Screen



Quality Allocation Screen



- 1 Tree species selection
- 2 Stump height
- 3 DBH
- 4 Trunk length
- 5 Crown length

- 6 Tree height
- 7 Tree volume
- 8 Topping length
- 9 Save input
- 10 Delete last line

- 11 New line
- 12 Start column
- 13 Quality column
- 14 Quality column
- 15 Optimize scheme

Figure 5: Functionality of Tree Parameter and Quality Allocation Screen.

3.3.4 Optimized bucking scheme

After pressing the **"Optimize scheme"** button, the **Optimized Bucking Scheme Screen** (Figure 6) opens and the value-optimized bucking scheme solution is presented. The table includes the columns **"Length"** (L, nominal length of the assortment in m), **"Start-End"** (S-E, start and end point of the assortment including standard excess length, user specific excess length and cutting slit in m from felling cut), **"Quality"** (Q, quality of the assortment), **"Diameter Class"** (DC, diameter class according to the middle diameter of the assortment according to Austrian Timber Trade Guidelines, middle diameter is determined from at half the nominal length from the top end of the assortment), **"Volume"** (V, m³ without bark) and **"Revenue"** (R, in € per assortment). Each line represents an assortment. The last line contains the part that is not utilized (Quality "Rest"), for which no diameter class, volume or revenue are displayed. For defect sections, these parameters are displayed. At the bottom, the sum of volume and revenue is displayed. If the user is satisfied with the suggested scheme, she/ he can proceed to bucking via the **"Proceed"** button at the bottom left. To enter a customized bucking scheme, the **Customized Bucking Scheme Screen** (Figure 6) is opened by the **"Customize scheme"** button.

3.3.5 Customized bucking scheme

The appearance of the customized bucking table is similar to the table in the **Optimized Bucking Scheme Screen** (Figure 6) however, here the user can alter nominal length and quality by choosing a different nominal length or quality. Assortments can be removed or added via pressing the screen on the desired location for two seconds until a sub-menu pops up. Select **"Insert"** for a new line and use **"Delete"** for removing an existing one. Sections previously specified as "defect" cannot be removed during customized bucking. Alteration of the assortment numbers by removing or adding an assortment has not been implemented yet. Schemes can repeatedly be altered and the results can be viewed via the **"Update"** button at the bottom right. If the user is satisfied with his choice, the **"Save"** button at the bottom left has to be selected to proceed to the **Comparison Screen** (Figure 7). On the **Comparison Screen** the **Suggested Scheme** and the **Customized Scheme** are compared in terms of revenue, volume and utilized length and the difference is shown in the column **"Difference"**. By selecting the desired scheme and pressing the **"Buck"** button, the user proceeds to the visualization (**Bucking Screen**) (Figure 7).

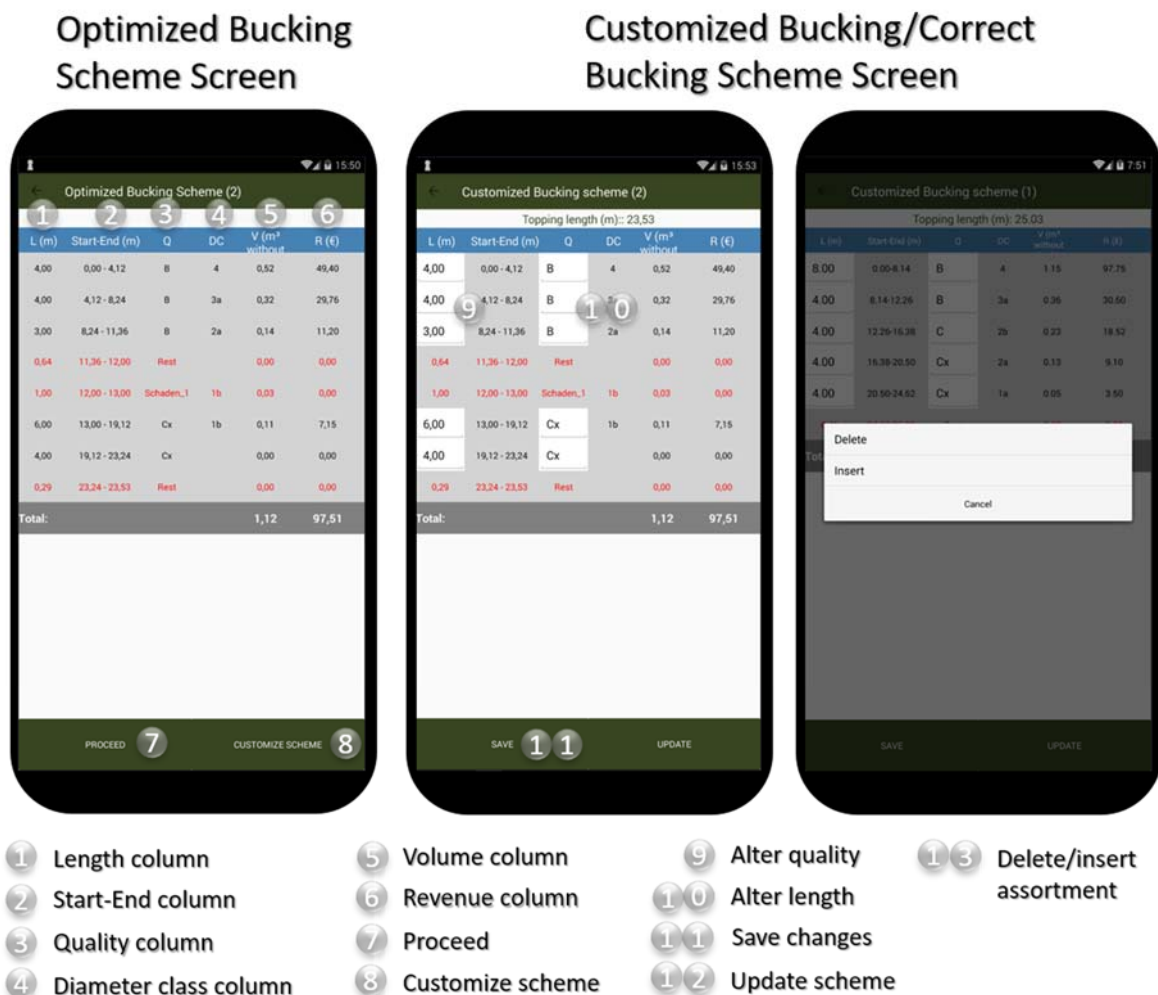


Figure 6: Functionality of the Optimized Bucking Screen and Customized Bucking/ Correct Bucking Scheme Screen.

3.3.6 Bucking

The **Bucking Screen** (Figure 7) shows two different visualisations of the tree, with the felling cut side at the bottom of the screen and the tree top side on it's top. On the left-hand side, the **Quality visualisation** displays the succession of assortment qualities, where assortments of the same quality are coloured alike. On the right-hand side, the **Length visualisation** displays the assortments and the cutting points in meters from the felling cut. In the middle, assortment **Volume, Revenue and Assortment length** are displayed. If the user has finished bucking the tree according to the selected scheme, bucking is finalised by pressing the **"Finish bucking"** button at the bottom left and the bucking scheme is saved to the operation statistics. If the user wishes to alter the bucking scheme during bucking, she / he has to proceed via the **"Correct scheme"** button at the bottom right. After pressing the **"Finish bucking"** button, the user is asked whether to proceed with the next tree or to end bucking and return to the **Operation Screen** (Figure 4).

3.3.7 Alteration of bucking scheme during bucking

The **Correct Bucking Scheme Screen** works similar to the **Customized Bucking Scheme Screen** (Figure 6) and as described in 1.1.1. Already cut assortments must not be altered. No **Comparison Screen** is shown after returning to bucking via the **"Save"** button.

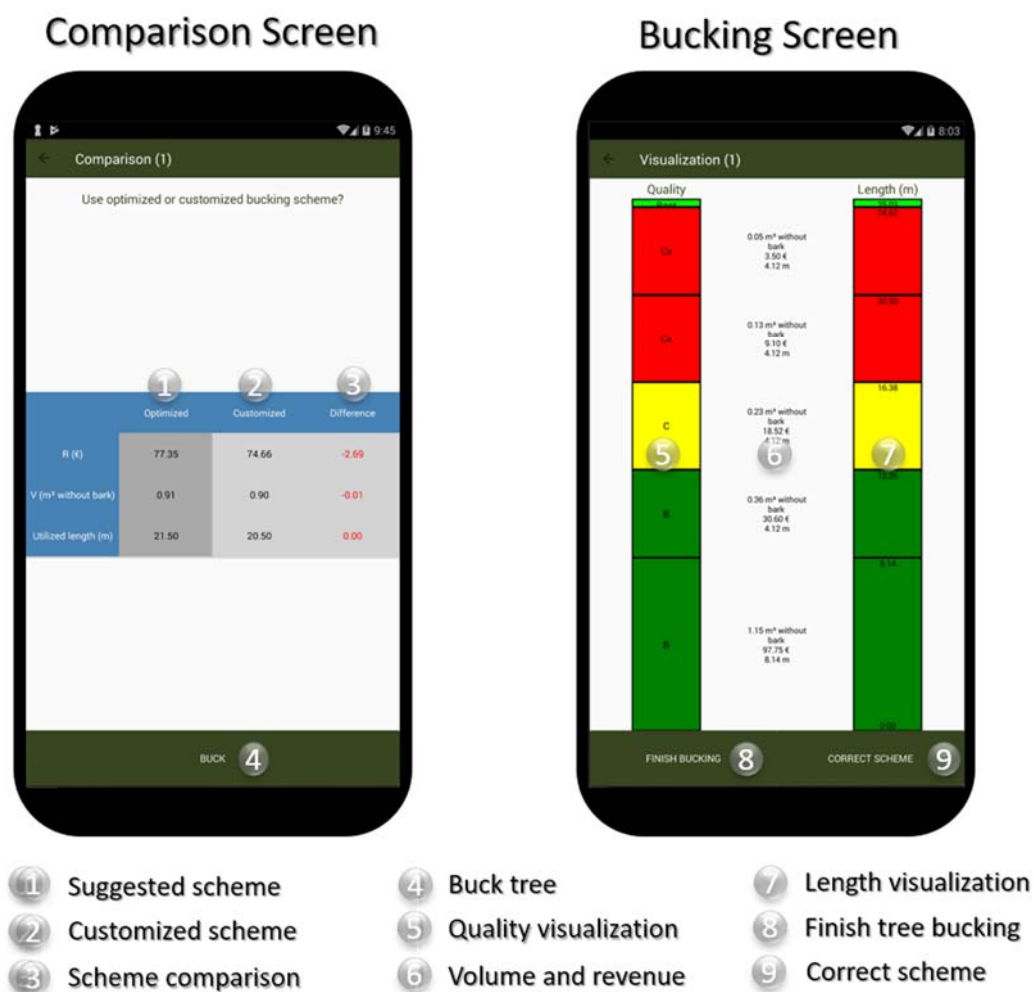


Figure 7: Functionality of the Comparison Screen and the Bucking Screen.

3.4 Statistics

3.4.1 Tree by tree and assortment statistics

From the **Operation Screen** (Figure 4), the **Tree By Tree Statistic Screen** (Figure 8) can be accessed for the selected operation via the “Tree by tree statistic” button in the top right menu. The top table (**Tree Details**) contains line by line all trees saved to the operation, successively numbered. The columns include **Species** (SP), **DBH**, **Tree height** (in m), **Volume without bark** (V, in m³ per tree) and **Revenue** (R, in € per tree). By selecting a tree, the respective assortments from this tree are displayed at the bottom in a similar format as for the **Optimized Bucking Scheme Screen** or the **Customized Bucking Scheme Screen**. Individual trees can be selected and deleted via the “Delete tree” button in the top right menu. From the **Operation Screen** (Figure 4), the **Assortment statistic Screen** (Figure 8) can be accessed for the selected operation via the “Assortment statistic” button in the top right menu. The table summarizes line by line all similar assortments defined by **Species** (SP), **Nominal length** (L), **Quality** (Q) and **Diameter class** (DC). For each assortment, the **Cumulated numbers**, **Volumes** and **Revenues** are presented. To return to the **Operation Screen**, the “Return” button at the bottom left is used.

Tree By Tree Statistics Screen Assortment Statistic Screen

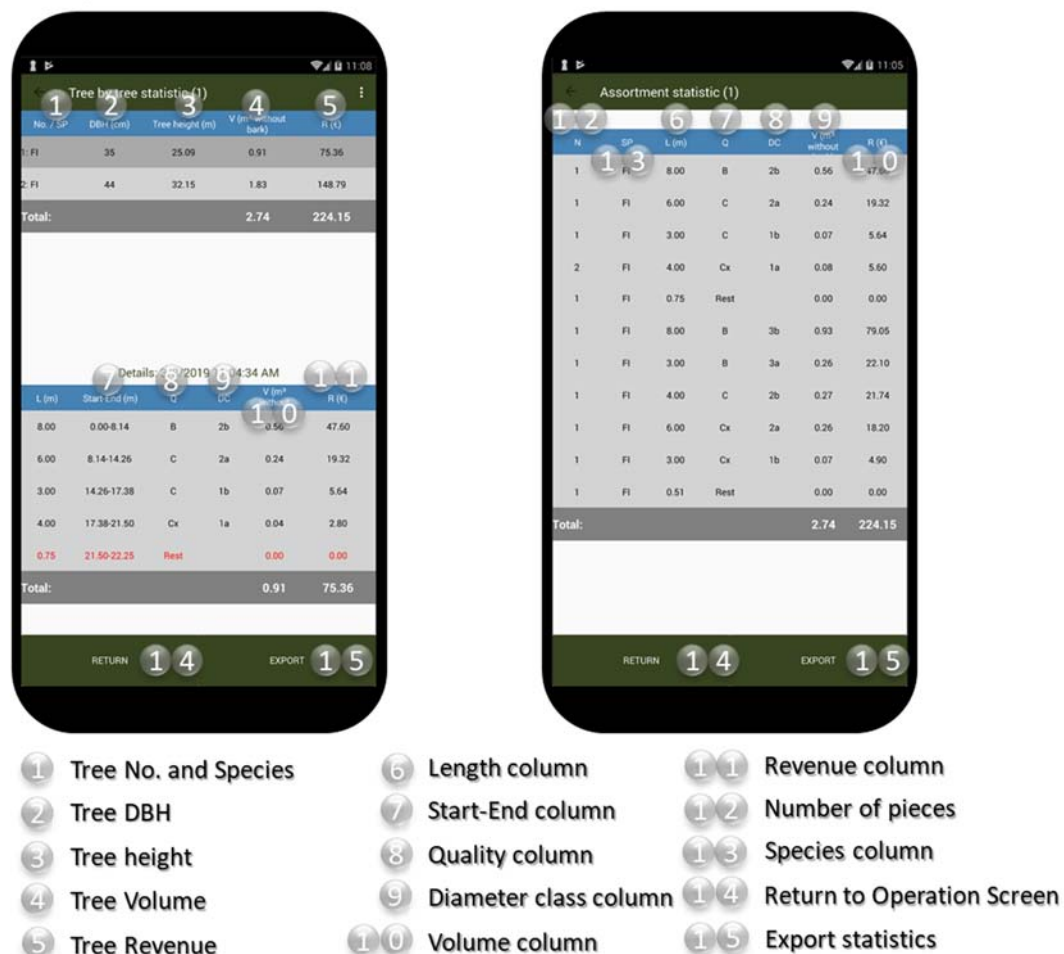


Figure 8: Functionality of the Tree By Tree Statistic Screen and the Assortment Statistic Screen.

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 720757.

3.4.2 Statistics export

Both tree by tree and assortment statistics data can be exported via the “**Export**” button at the bottom right. The user can choose which statistic to export – either one of them or both. Statistics are exported as .pdf files (Figure 9) and additional export as a .csv can be selected. Exported data can be retrieved from the app’s “Export”-folder. The folder can be accessed on the mobile device via the **Android FileManager** (“**Android**” -> “**data**” -> “**com.latschbacher.buckingapp**” -> “**files**” -> “**Export**”) and the file can be transferred to other mobile devices or PCs via USB, Bluetooth, mail or other means of data transmission.

No.	1
Operation	Karl
Date	15.05.2019 - 15.05.2019
Additional text	
Stand designation	Rainfeld
Sea level height [m]	370
Bucker	

No.	Species	DBH (cm)	Tree height (m)	Topping length (m)
1	FI	49	24,80	22,74
L (m)	Q	DC	V (m³ without bark)	R (€)
4,00	ABC	4	0,63	50,40
12,00	ABC	3a	0,92	84,64
4,00	ABC	1b	0,09	5,18
2,32	Rest		0,02	0,00
Total:			1,66	140,22

No.	Species	DBH (cm)	Tree height (m)	Topping length (m)
2	FI	56	25,30	23,50
L (m)	Q	DC	V (m³ without bark)	R (€)
6,00	ABC	4	1,15	92,00
4,00	ABC	4	0,51	40,80
4,00	ABC	3a	0,35	28,00
4,00	IH	2b	0,20	5,56
4,00	IH	1b	0,07	1,95
0,90	Rest		0,00	0,00
Total:			2,28	168,31

No.	Species	DBH (cm)	Tree height (m)	Topping length (m)
3	BU	48	30,50	27,44
L (m)	Q	DC	V (m³ without bark)	R (€)
6,00	AB	4	0,92	76,36
4,00	AB	3b	0,48	39,84
4,00	AB	3b	0,38	31,54
6,00	IH	3a	0,45	18,86
6,00	IH	1b	0,12	5,03
0,84	Rest		0,00	0,00
Total:			2,35	171,63

Export date: 15.05.2019	1
-------------------------	---

Export date: 15.05.2019	2
-------------------------	---

N	SP	Q	L (m)	DC	V (m³ without bark)	R (€)
2	FI	ABC	4,00	4	1,14	91,20
1	FI	ABC	12,00	3a	0,92	84,64
1	FI	ABC	4,00	1b	0,09	5,18
1	FI	ABC	6,00	4	1,15	92,00
1	FI	ABC	4,00	3a	0,35	28,00
1	FI	IH	4,00	2b	0,20	5,56
1	FI	IH	4,00	1b	0,07	1,95
1	BU	AB	6,00	4	0,92	76,36
2	BU	AB	4,00	3b	0,86	71,38
1	BU	IH	6,00	3a	0,45	18,86
1	BU	IH	6,00	1b	0,12	5,03
Total:					6,27	480,16

Figure 9: Example export displaying tree by tree statistics (left) or assortment statistics (right).