Annotation Guideline

Read carefully the *General Information, Documentation* and *How to start the annotation process* before annotating.

Version – 04.11.2024

Inhalt

General Information

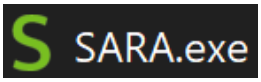
- The annotation is carried out using the SARA annotation tool. Please use the user manual in this document: „How to start the annotation process? - Short introduction to the annotation tool“
- **The video-recordings are annotated in 11 categories (Location, Sub-Processes, Activity, Pose - Legs, Pose Torso, Activity, Pose - Left Hand, Pose - Right Hand, Main-Process, Picking Order, Information Technology, Picking and Putting Error). The categories are annotated one after the other. So please only annotate the one category specified in the e-mail. As soon as you have finished, you will receive another annotation task from Friedrich Niemann.**
- **5 frames** are the MINIMUM size of an annotated time window / sample!
- Please only start annotating after the instructions (Kick-off). Start with the test recording first and annotate and upload it. If the test annotation is good enough and you have no more questions, you will receive your files to be annotated.
- After the annotation, we will revise the labels.
- If you have any questions, please contact
    - friedrich.niemann@tu-dortmund.de or
    - 0151 5630 4331 (WhatsApp / Signal)

Documentation of Annotation

- Annotation effort will be documented; this is not a contest who is the fastest!
- Use the file “Effort_Assessment__Annotator.xlsm” for the documentation. Fill in the white parts in this table.
- Please do not show your filled out file to any other annotator.

How to start the Annotation Process?- Short Introduction to the Annotation Tool

1. Download
    a. “Annotation_Guideline.pdf”
    a. “Annotation_tool.zip”
    b. “Effort_Assessment__Annotator.xlsm”
2. Extract the zip-file (“Annotation_tool.zip”) somewhere you like (e.g. Desktop)
3. Run the “SARA.exe” inside the extracted folder (path: Annotation_Tool/01 Windows_Executables) → The annotation tool starts. FYI: At the first start, an antivirus program may scan the tool. (Alternative: Python users can install the tool from PyPi: pip install annotation-tool)



4. Add your Annotator-ID
    c. “Options”
    d. “Settings”
    e. Add your ID (You will find your personal Annotator-ID in the e-mail that Friedrich Niemann sent you)
    f. (For MAC users: you will find the setting under "LARA" → "Preferences")
5. Under “File” → “Datasets”: First create a new dataset depending on what you want to annotate. Only create datasets for which you have the scheme-file and dependencies-file. In the beginning this is only "Location". You will receive the other files one after the other from Friedrich Niemann.
    g. Give the names
        i. “Data4Log_Location”
        ii. “Data4Log_Sub-Process”
        iii. “Data4Log_Activity”
        iv. “Data4Log_Pose - Legs”
        v. “Data4Log_Pose - Torso”
        vi. “Data4Log_Pose - Left Hand”
        vii. “Data4Log_Pose - Right Hand”
        viii. “Data4Log_Main-Process”
        ix. “Data4Log_Picking and Putting Error”
    h. Select the dataset-scheme (path: Annotation_Tool\03 Scheme,dependencies)
        i. scheme_Data4Log__Location.json
        ii. scheme_Data4Log__Sub-Process.json
        iii. scheme_Data4Log__Activity.json
        iv. scheme_Data4Log__Pose - Legs.json
        v. scheme_Data4Log__Pose - Torso.json
        vi. scheme_Data4Log__Pose - Left Hand.json
        vii. scheme_Data4Log__Pose - Right Hand.json
        viii. scheme_Data4Log__Main-Process
        ix. scheme_Data4Log__Picking and Putting Error
    i. Select the dataset-dependencies (path: Annotation_Tool\03 Scheme,dependencies)

i. dependencies_Data4Log__Location.json
ii. dependencies_Data4Log__Sub-Process.json
iii. dependencies_Data4Log__Activity.json
iv. dependencies_Data4Log__Pose - Legs.json
v. dependencies_Data4Log__Pose - Torso.json
vi. dependencies_Data4Log__Pose - Left Hand.json
vii. dependencies_Data4Log__Pose - Right Hand.json
viii. dependencies_Data4Log__Main-Process
ix. dependencies_Data4Log__Picking and Putting Error

j. Click on "Add" and make sure the new dataset has been added on the list on top of the window.

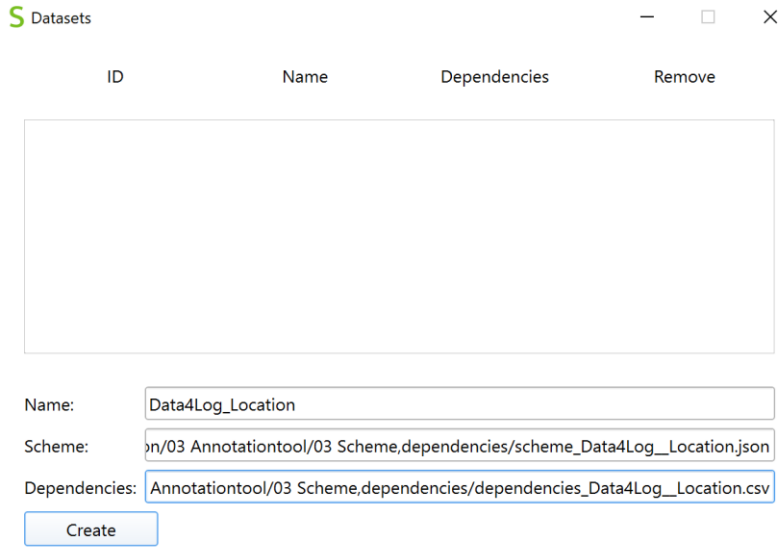


Figure 1: Creating the dataset "Data4Log_Location"

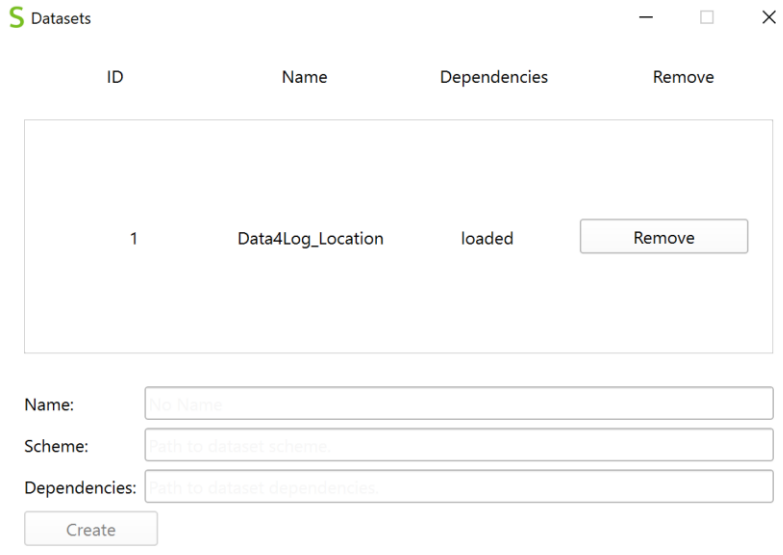


Figure 2: All created datasets in the annotations tool SARA

6. Fill in the annotation documentation file "Effort_Assessment__Annotator.xlsm"
   a. "Metadata"
      i. Please fill in the third row. The second row serves as an example.

ii. Only the white parts of the table can be filled.

b. “Documentation”

i. You can document your annotation from row three.

ii. Both your time and incidents are documented. This is NOT a competition to see who is the fastest!!!

iii. Row 3 and 4 are filled in as examples. You are welcome to overwrite them.

7. Using “File” → “New” (or Hotkey: Ctrl+N) create a new Annotation-File

a. Select the dataset you want to annotate the file for (you start with “Data4Log_Location”)

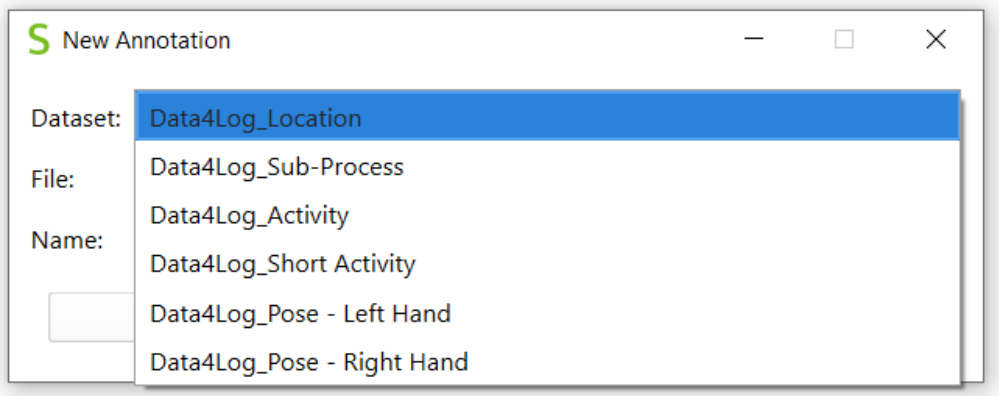


Figure 3: Selection of the dataset to be annotated

b. Select the **subject**-file (e.g. “Subject_06”) you want to annotate by clicking on the field “No File selected” and finding it using the file-explorer

c. Choose a name. **Please name the annotation as specified in the Excel file ("Effort_Assessment__Annotator.xlsm"): e.g. *S05_A01_Location_AR01* and click on “Create” (Delete the blank space at the end of the name, if there is one)**

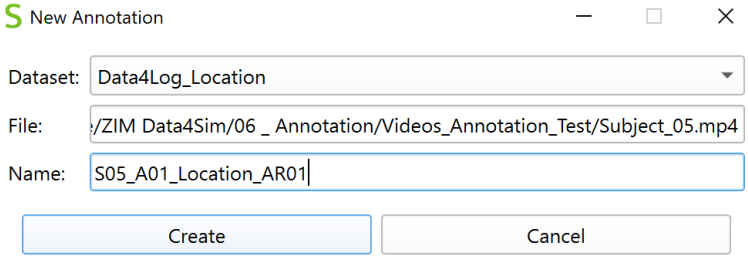


Figure 4: Select the file to be annotated (please select the subject video)

Subject [S]	Color of the top	Annotator [A]	Annotation Revision	Class	Annotation [AR] / Revision Run	NAME OF THE ANNOTATED FILE
05	purple	01	Annotation	Location	01	S05_A01_Location_AR01

Figure 5: You will find the name of the file to be annotated in the Excel file

8. Add Video file

a. Right click on the video stream

b. Search for more video files of the same recording session

i. There are 6 more camera angles available. **It is recommended to add videos 1 and 2**.

ii. During the annotation you can always remove or add videos.

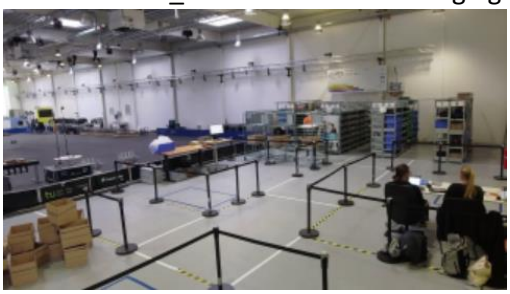
iii. All video angles:

1. **Fixed Camera _ Overview 1 _ Rack Storage System**

2. **Fixed Camera _ Overview 2 _ Open Areas**

3. Fixed Camera _ Direction to the Rack Complex 1

4. Fixed Camera _ Direction to the Packaging Area



5. Fixed Camera _ Direction to the Goods Issue Area

6. Fixed Camera _ Office

Figure 6: Left video is the primary video (subject video only, please). On the right are further videos for support.

9. Read this “Annotation_Guideline” carefully

10. Start annotation

11. Play recording, or Hotkey: [Space]
    a. Pause recording if activity changed, or Hotkey: [Space]
    b. Click on “Cut & Ann.”, or Hotkey: [X]
    c. Select Class, e.g. “Office”
    d. Click on “Save” (Result: first window was set and labeled)
    e. Go on with step a) till the hole recording is labeled
    f. FYI: As soon as a class changes due to the subject's movement, a new window with new labels must be set. Depending on the variation of the movements and the speed of the subject, **a recording** can thus consist of **dozens** or even **thousands of windows**.

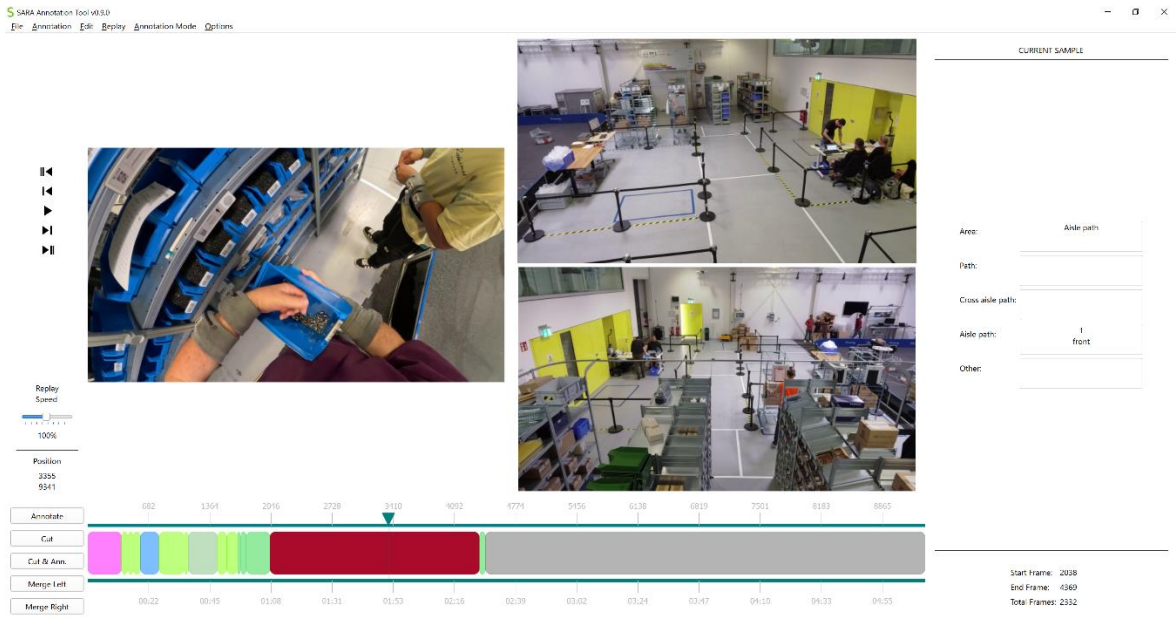


Figure 7: Excerpt from the annotation process "Location"

<u>Annotate the videos even if the left video stream is black</u>, as long as you can recognize what the person is doing in other videos! The action camera may not have recorded due to a battery change or other reasons. However, all other cameras and sensors have continued to record.

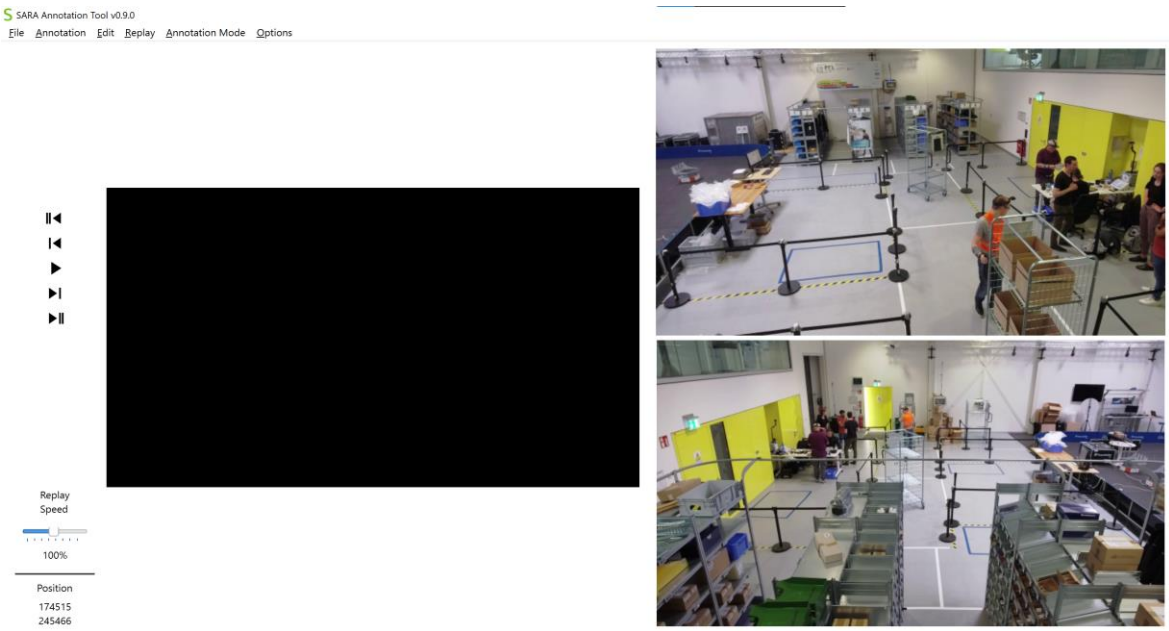


Figure 8: Example of a black video stream. After changing the battery of the action camera, the recording was only started later. However, all other cameras and other sensors recorded the subject's movement. This black sequence is to be annotated. Focus more on the other cameras.

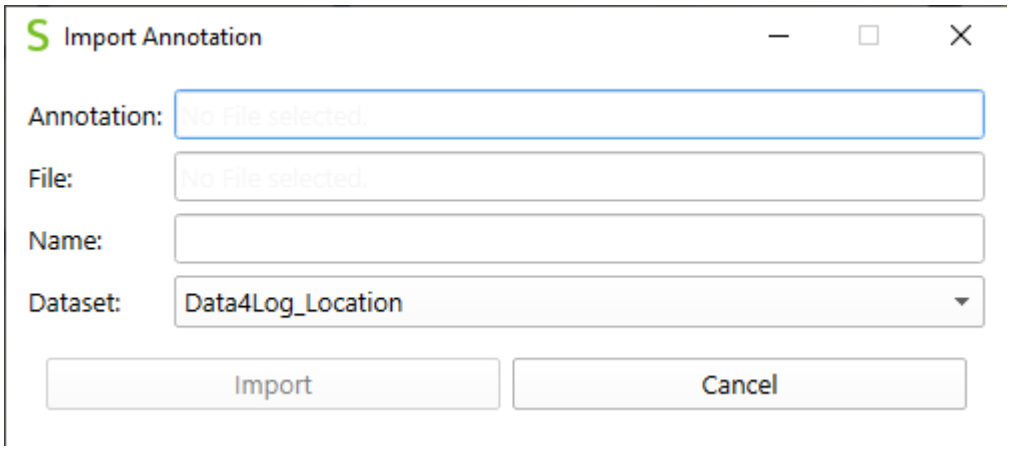
12. Save annotation using "File" → "Save", or Hotkey: [Ctrl+S]

13. Once you have annotated the entire recording, you can export the file and upload it to Sciebo.
    a. "File"
    b. → "Annotations"

c. → "Export"
d. → select only "Compress to zip"
e. → "OK"
f. → Search path: Annotation_Tool\05 Annotation
g. → Click "Select folder" (Note: You will not receive a notification that the file has been exported successfully. Please check the corresponding folder to see whether the file has been exported or not.)
h. Upload the zip export (e.g. "annotation_S06_A01_Sub-Process_AR01_by_1") as a ZIP to Sciebo (You will find your personal upload link in the e-mail that Friedrich Niemann sent you)
i. Upload the annotation documentation file "Effort_Assessment__Annotator.xlsm" to Sciebo (use the same link like in the step before)

How to import annotated Files?

1. If the correct dataset is not available, it must be created.
2. Import annotated file
   - File → Import → Select:
     - Annotation: select the annotation Excel file
     - File: select the video of the subject
     - Name: Change the old name. You can take the new name from your personal Excel file, e.g.:
       - Old: annotation_S04_**A05_Activity**_AR01
       - New: S04_**A04_Short Activity**_AR01
       - Or new: S04_**A04**_Activity_**RR01**
     - Dataset: Please select the dataset you want to use.



3. After the import, you have to open the annotation: File → Open → Select the annotation
4. Depending on what your task is, you can then start with the annotation and/or revision.

Annotation Levels

Location

You can see the locations on the following floor plan. In the videos, the locations are marked on the floor with white tape. A new window is set exactly when at least **one foot** and the largest part of the subject's body is in a new location. The active movement of the subject into a location also serves as orientation.

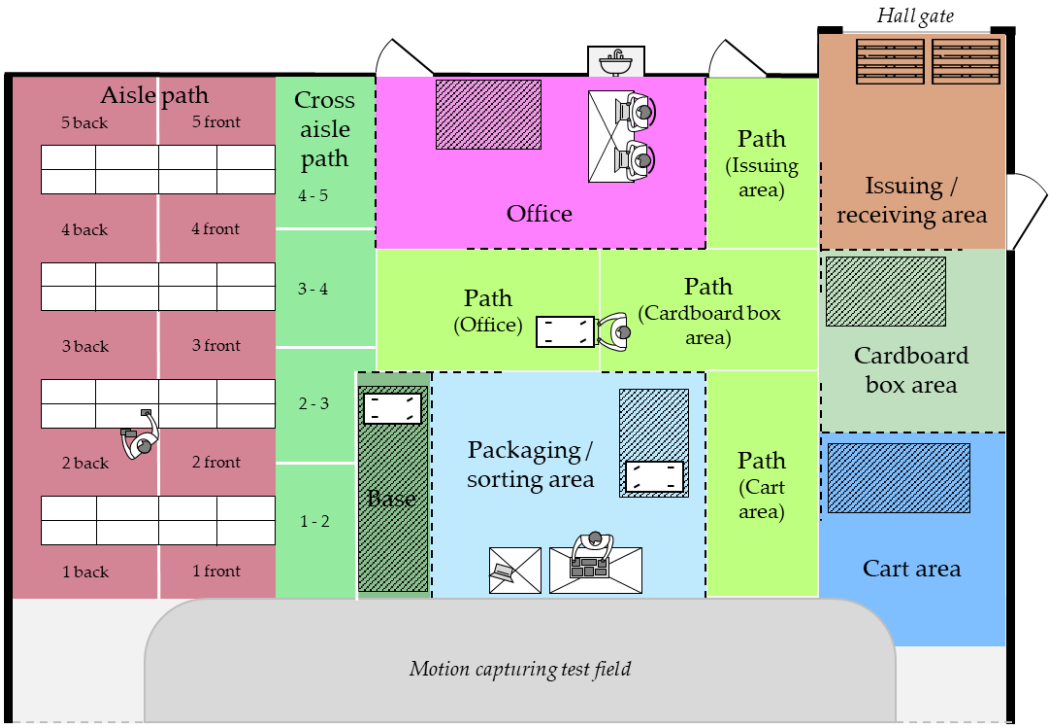


Figure 9: Floor plan of the data recording. The colors match the colors in the annotation tool.

Figure 10: Representation of the Location in the annotation tool

Area

Only select ONE Area per window. As soon as the Area changes, a new window must be created.

(1) Office

(2) Cart area

(3) Cardboard box area

(4) Base

(5) Packaging/sorting area

(6) Issuing/receiving area

(7) Path
The "Path" is divided into four areas, which can be selected in (10)-(13).

(8) Cross aisle path
The "Cross aisle path" is divided into four areas, which can be selected in (14)-(17). They indicate the transition from one aisle to the next.

(9) Aisle path
The "Aisle path" is divided into ten areas, which can be selected in (18)-(24). The five aisles are divided into front and back, resulting in ten areas.

Path

If you select Path (7) you have to select one Path (10-13). As soon as the Path changes, a new window must be created.

(10) Path (Office)

(11) Path (Cardboard box area)

(12) Path (Cart area)

(13) Path (Issuing area)

Cross aisle path

If you select Cross aisle path (8) you have to select one Cross aisle path (14-17). As soon as the Cross aisle path changes, a new window must be created.

(14) 1-2

(15) 2-3

(16) 3-4

(17) 4-5

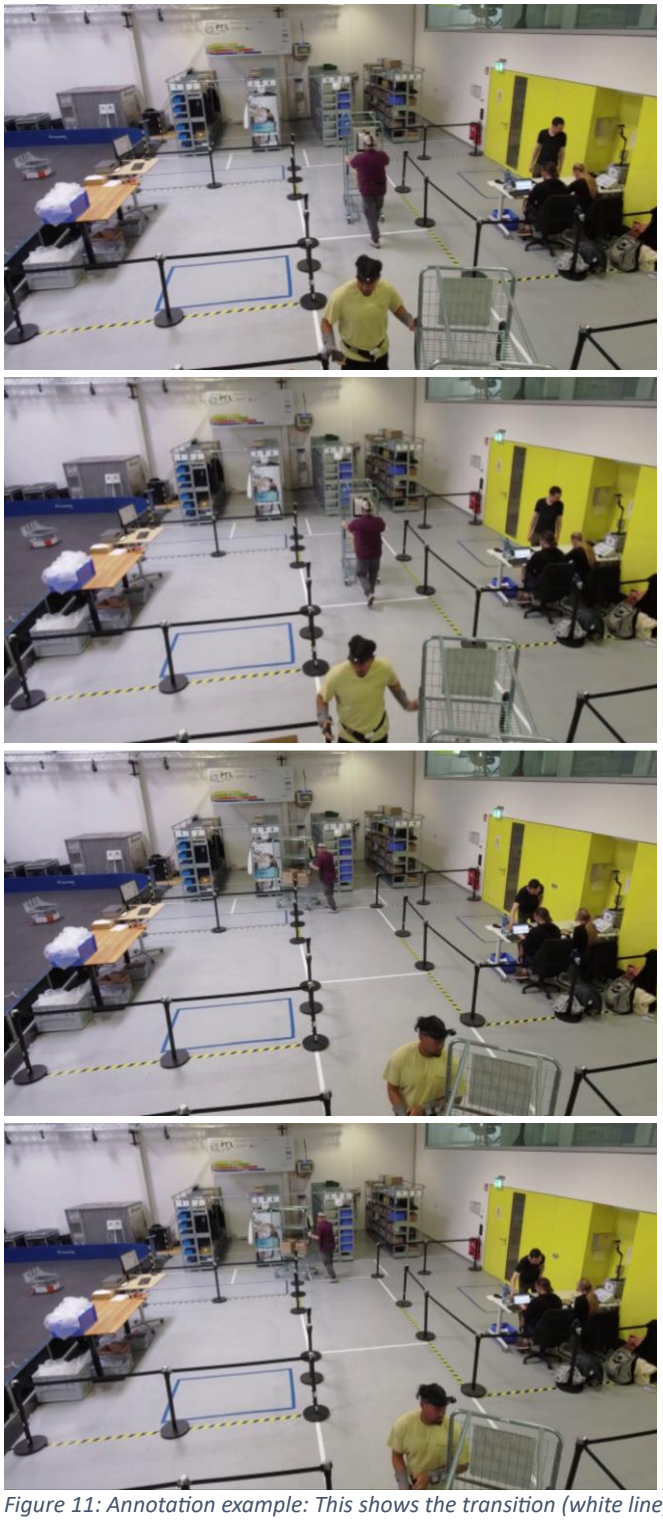


Figure 11: Annotation example: This shows the transition (white line) from the subject with the purple shirt from (11) "Path (Cardboard box area)" to (10) "Path (Office)" as well as the transition from (10) "Path (Office)" to (16) "Cross aisle path 3-4".

Aisle path

If you select Aisle path (9) you have to select one Aisle path (18-22) AND the position inside the Aisle (23 or 24). As soon as the Aisle path changes, a new window must be created.

(18) 1

(19) 2

(20) 3

(21) 4

(22) 5

(23) front

(24) back

Other

(25) ANOTHER LOCATION
If the subject is outside the test area, e.g. going to the toilet, you can select OTHER.

(26) LOCATION UNKNOWN
If the subject is within the test area but you cannot see exactly where they are.

Figure 12: Example of a 4438 long annotated sequence. The colors match the colors from the floor plan.

Activity

Only select <u>ONE</u> Activity per window. As soon as the activity changes, a new window must be created.

If two activities are carried out simultaneously (e.g. walking and parallel handling), the following order applies: *Synchronization → Tick off → Scan → Handling* upwards → *Handling* centred → *Handling* downwards → *Pull / Push → ANOTHER ACTIVITY → Walking / Standing / Sitting*. According to this order,

- "pushing a cart during walking" would be labeled as *Push* and not *Walking*
- "Grasping an item during walking" would be labeled as *Handling centred* and not *Walking*
- "Handling the cart during standing" would be labeled as *Handling centred* and not *Push*, *Pull* or *Standing*
- "Typing on the Portable Data Terminal" would be labeled as *Tick off* and not *Handling*

(1) Synchronization
- There are up to three synchronization movements at the beginning and End of each recording.
  - I. Waving movement with both hands over the head. Stops as soon as the subject's arms are back at the side of the body.
  - II. Both hands are consolidated in front of the chest. Stops as soon as the subject's arms are at the side of the body again.
  - III. Bouncing
  - IV. Clapping the hands

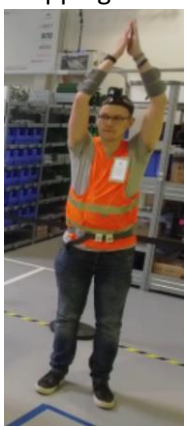


Figure 13: Waving movement with both hands over the head (I)

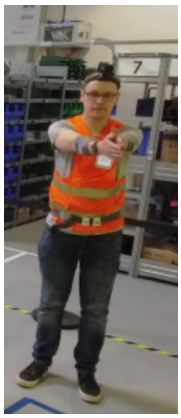


Figure 14: Both hands are consolidated in front of the chest (II)

Figure 15: Bouncing (III)

(2) Tick off / confirm
- Writing with a pen on a picking list
- Typing on the screen (e.g. Portable Data Terminal)
- Pressing a button on a pick-by-light frame

Figure 16: Writing with pen

Figure 17: Tapping a screen with the right thumb

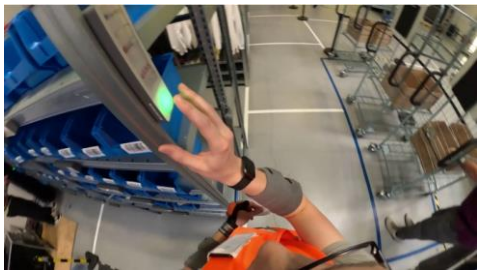


Figure 18: Pressing a button on a pick-by-light frame

(3) Scan

- Scanning using the glove scanner or the Portable Data Terminal
- The entire movement towards the barcode counts, not just the scanning

Figure 19: Scanning with the Portable Data Terminal

Figure 20: Sanning with the glove scanner

The handling activities refer to a motion of the upper body, not to holding onto something (Holding e.g. when pushing a cart or holding a box while walking). But it refers to handling the cart before or after moving it to a new position.
A gripping or handling activity must be clearly recognisable.
The entire movement is considered. For example, if the subject handles in a bent posture (*Handling downwards*), the movement counts from the upright posture to bending down, handling in a bent posture and to standing upright.
Handling includes not only gripping, but also other movements, such as counting screws by hand.

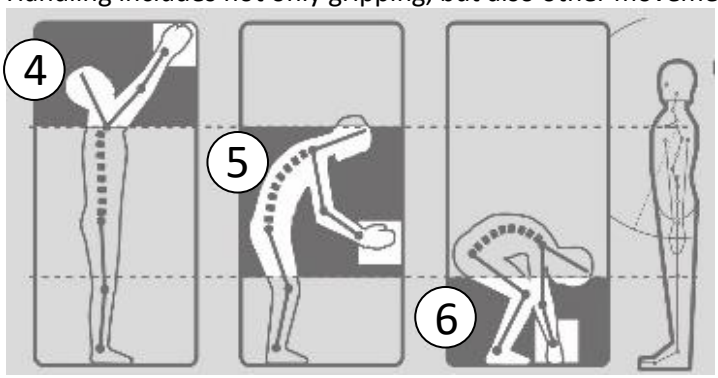
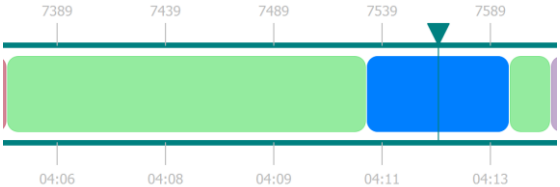


Figure 21: Handling activities based on the height of the hands.



A handling activity can be interrupted by another activity. Example: a "tick off / confirm" activity takes place during a downwards movement. As "tick off / confirm" is prioritised higher, "tick off / confirm" is selected within the handling movement. This can result in three windows even if it is only a downwards movement: "Handling downwards" (green window) → "tick off / confirm" (blue window) → "Handling downwards" (green window)

(4) Handling upwards

- At least one of the used hand is on the same height as the shoulder joint or higher

Figure 22: One Handling upwards movement

(5) Handling centered

- Handling is possible without bending over, kneeling or lifting arms to shoulder joint height
- as it is not possible to lift an item without tilting your spine at all, take the direction of the participant's sight for reference: does he/she look forward or downwards?

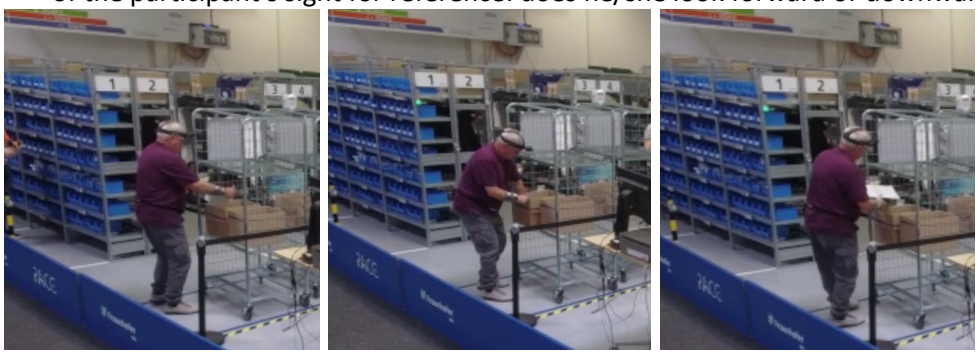


Figure 23: One Handling centered movement

(6) Handling downwards

- Legs or back need to be adjusted for handling
- e.g. kneeling, bending over etc.
- Back is tilted to a horizontal line or further

Figure 24: One Handling downwards movement. The movement ends after the subject stands upright again.

(7) Pull

- Pulling the cart to a new position with a single or both hands
- Tip: Look at the wheels on the cart. These indicate whether the cart is being pushed or pulled.
- does not include the handling of items/boxes on the cart (this is considered handling)
- does not include the gripping of the cart handles (this is considered handling)
  - Gripping the cart = handling
  - Walking with the cart almost always pull or push.

Figure 25: Pulling the cart

(8) Push

- Pushing the cart to a new position with a single or both hands
- Tip: Look at the wheels on the cart. These indicate whether the cart is being pushed or pulled.
- does not include the handling of items/ boxes on the cart (this is considered handling)
- does not include the gripping of the cart handles (this is considered handling)
  - Gripping the cart = handling
  - Walking with the cart almost always pull or push.

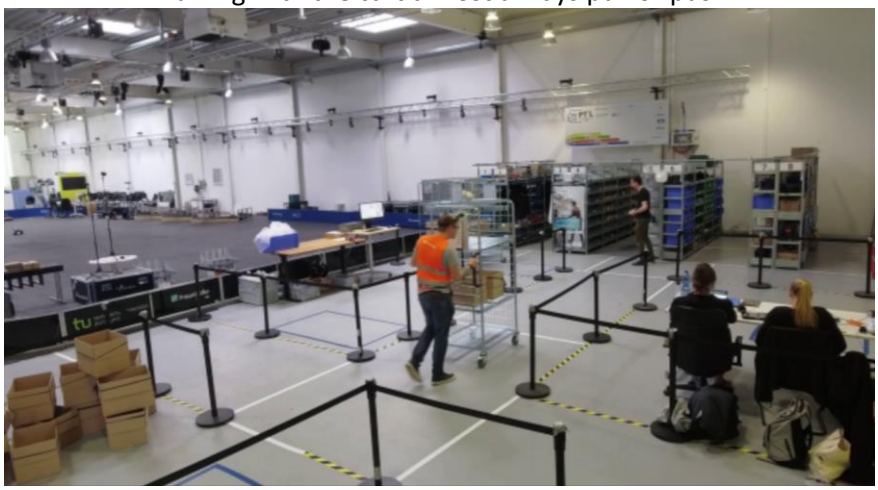
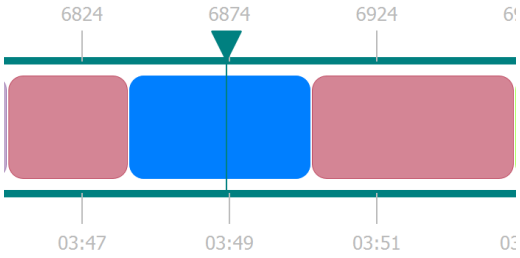


Figure 26: Pushing the cart

(9) Walking

- See pictures for example
- Gait cycle while moving to a new position
- No difference made in regards to whether something is carried or not
- As with handling movements, "Walking" can also be interrupted by another activity. Example: While walking, the subject presses a button to confirm the retrieval ("tick off / confirm"). Even if the person is walking at the same time, "tick off / confirm" must be labelled.



Therefore, three windows can be set for a walking movement: "Walking" (red window) → "tick off / confirm" (blue window) → " Walking " (red window)

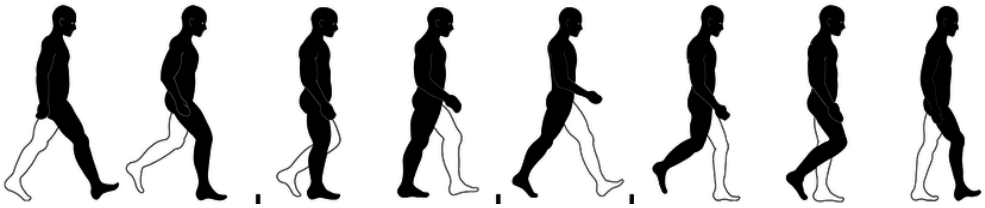


Figure 27: Gait Cycle

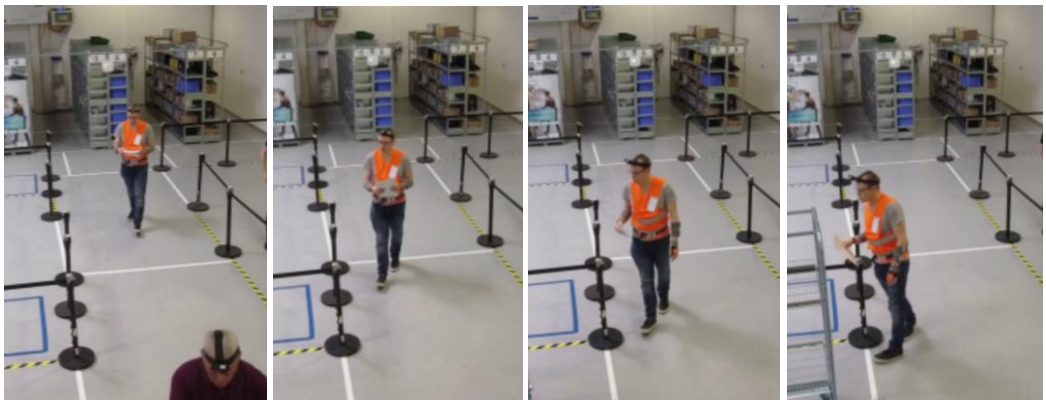


Figure 28: Walking (no handling, just walking and holding an item at the same time)

(10) Standing

- Standing while not doing any specific action
- Smaller steps while standing are still considered standing
- One can hold boxes, a cart or other items meanwhile

Figure 29: Standing (no handling, no walking, just standing still)

(11) Sitting

- Sitting on a chair, table or cart

(12) ANOTHER ACTIVITY

- The handling of logistics devices (scanner, Portable Data Terminal, picking list, ...) belongs to the handling activities, scan or confirm.
- Unspecified non-logistic activities, e.g.
  - Scratching your nose
  - Looking at a wristwatch
  - Handle private wristwatch
  - Handle bracelet or necklace
  - Writing with the private smartphone
  - Handling a GoPro, IMU or smartphone that is in the vest
  - Drinking water
  - Throwing a ball

(13) ACTIVITY UNKNOWN

- Frames that shall not be taken into account, because the activity is not recognisable.
- Reasons can be errors/gaps in the recording. As long as at least one camera captures the person, the sequence can be annotated. This also applies if the video stream from the subject's action camera is black.
- Also, the subject may be moving outside the camera range

Pose – Legs

Only select <u>ONE</u> leg pose per window. As soon as the leg pose changes, a new window must be created.

If possible, please do not use the "Merge" function in the annotation tool, as the activity labels may be different, even if the leg poses are the same.

(1) Gait Cycle
- see pictures below

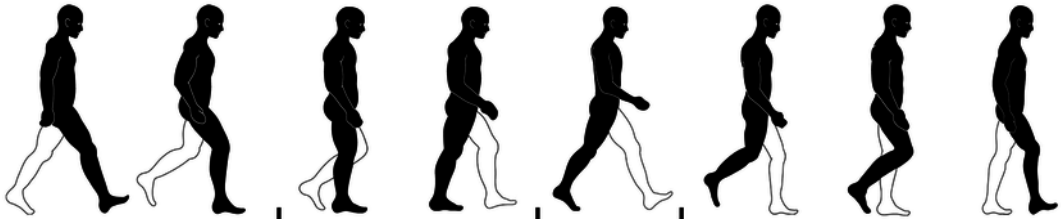


Figure 30: Gait Cycle

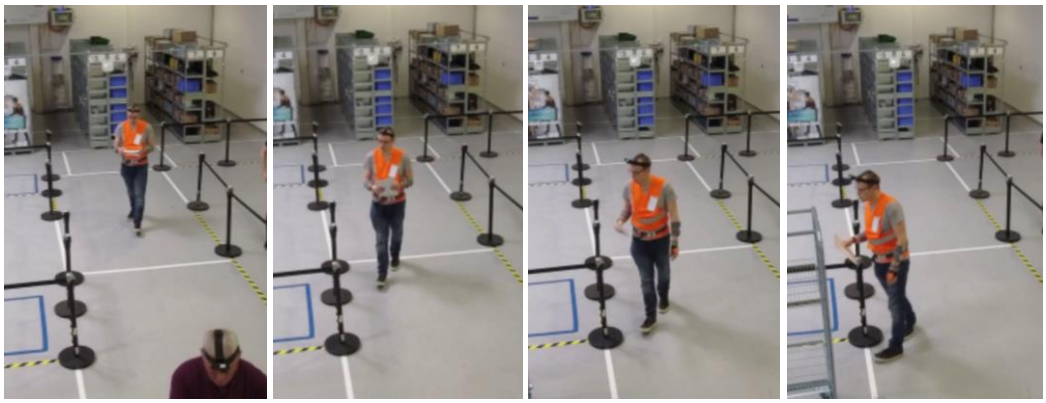


Figure 31: Gait Cycle

(2) Step
- A single step without a foot swing. This can also refer to a step forward, followed by a step backwards using the same foot.
- A step requires one foot to leave the ground and at least a slight shift of the upper body.

(3) Standing Still
- Both feet stay on the ground

(4) Sitting
- Sitting on a chair, table or cart.

(5) Squat

- Squatting movement and posture that is often accompanied by downward handling
- During this movement, the legs can stand still or take small steps (still count as Squat). You can see in the pictures, that the subject is moving during his Squat movement over the white line. The hole movement count as Squat and not as Step.

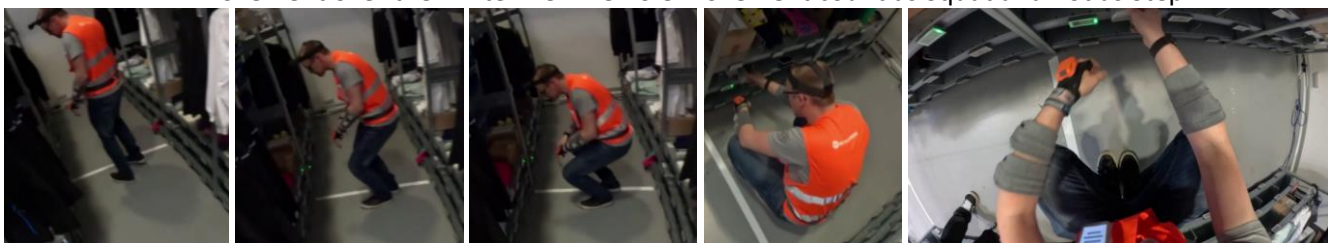


Figure 32: One Squat movement (The missing straightening of the upper body here is also part of the "Squat" pose.)

Figure 33: Squat

(6) Lunges

- see picture below
- The entire sequence applies, from the first step, to kneeling, to remaining in the kneeling position, to standing up.

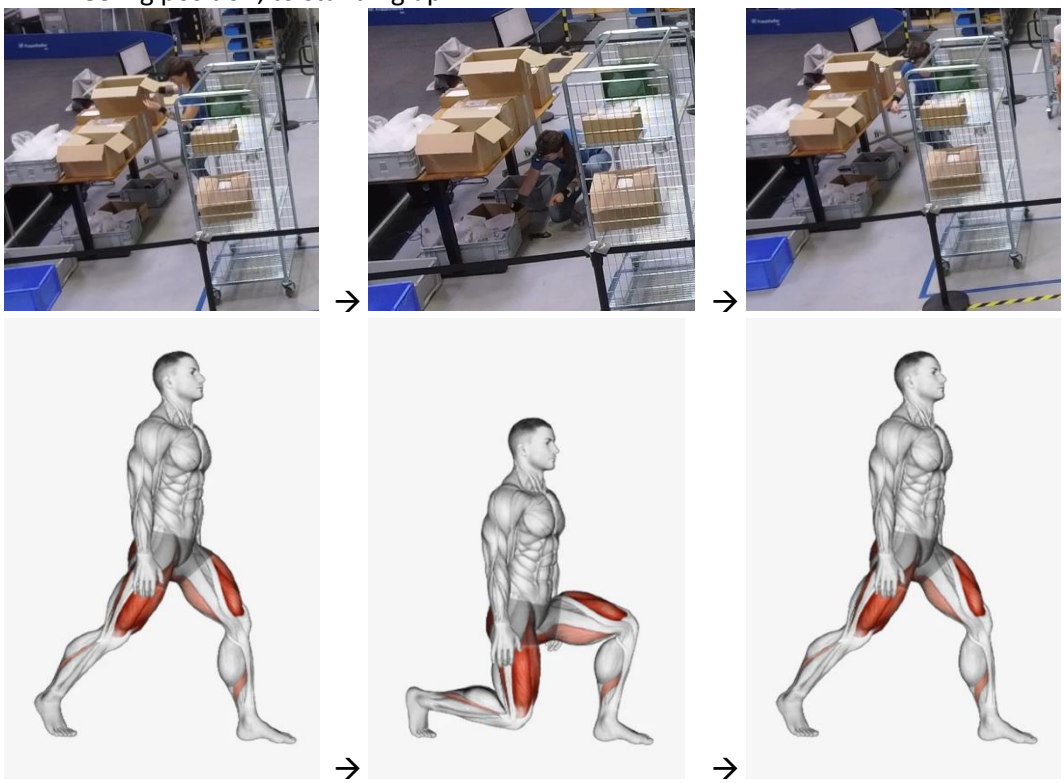


Figure 34: One Lunges movement

(7) ANOTHER LEG POSE

- Unspecified leg pose: none of the above leg poses applies, e.g. jumping.

(8) LEG POSE UNKNOWN

- Frames that shall not be taken into account, because the leg pose is not recognisable.
- Also, the subject may be moving outside the camera range

Pose – Torso

Only select <u>ONE</u> torso pose per window. As soon as the torso pose changes, a new window must be created.

(1) No Bending

- see picture below
- The subject's upper body is approximately in line with his legs (<u>bending under 10 degrees</u>)
- Most of the time the upper body will not be bent.

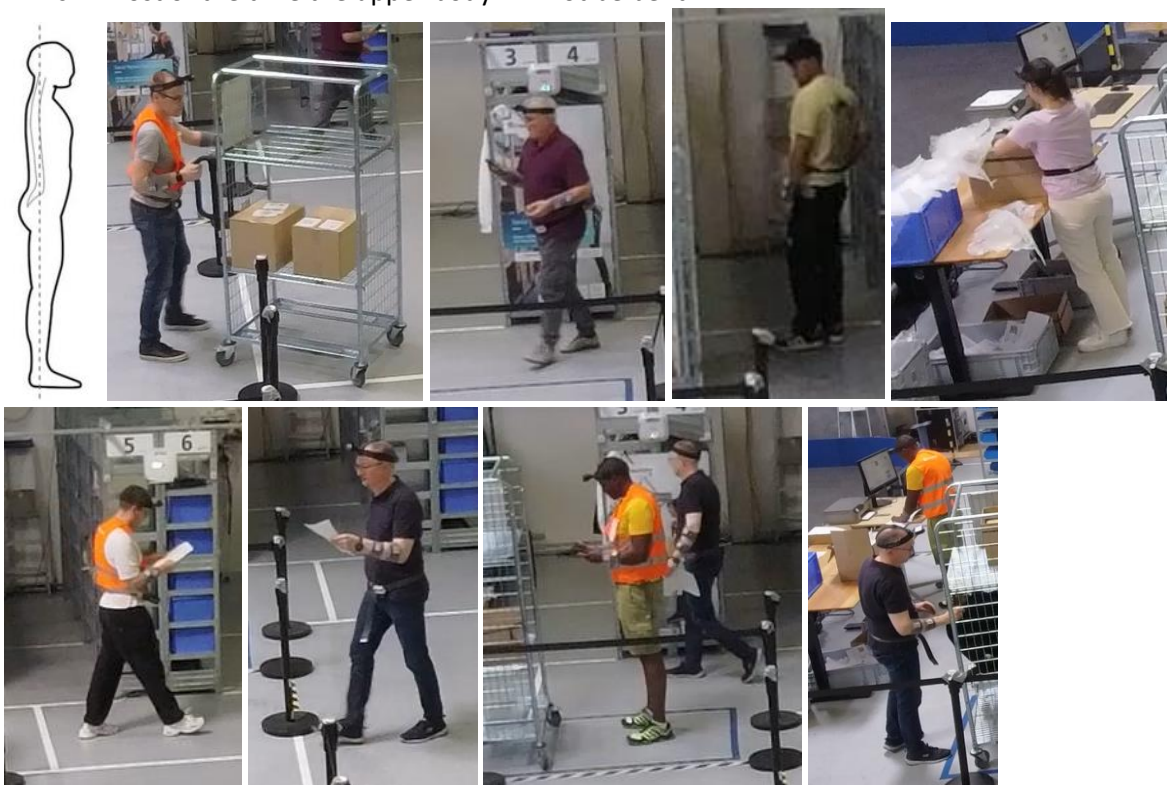


Figure 35: Examples of No Bending

(2) Slightly Bending

- see pictures below
- The subject's upper body is not in line with his legs
- The bending should be clearly recognizable (<u>bending between 10 and 30 degrees</u>).
- Also pay attention to bending sideways while, for example, placing items in the cart. These movements are also considered bending.

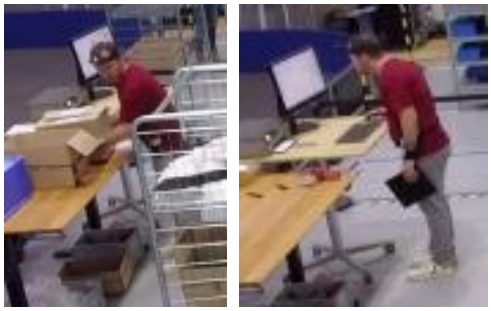


Figure 36: Examples of Slightly Bending

(3) Strongly Bending

- see pictures below
- The subject's upper body is not in line with his legs
- The bending should be clearly recognizable (bending over 30 degrees).

Figure 37: One bending movement

Figure 38: Examples of Strongly Bending

(4) Torso Rotation
- see picture below
- Rotation in the transverse plane
- Either a rotating motion, e.g. when taking something from the cart and turning towards the shelf or a fixed position when handling something while the torso is rotated.
- The torso rotation must be clearly recognizable. Depending on the shot, torso rotation may rarely occur or not at all.

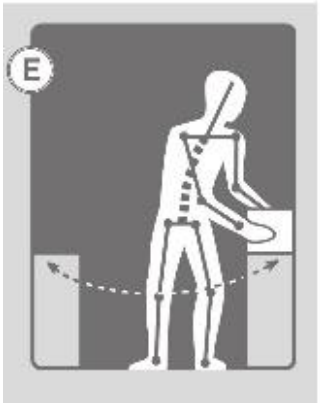


Figure 39: Torso Rotation

(5) ANOTHER TORSO POSE
- Unspecified torso pose: none of the above poses applies.

(6) TORSO POSE UNKNOWN
- Frames that shall not be taken into account, because the torso pose is not recognisable.
- Also, the subject may be moving outside the camera range

Pose – Left Hand

Poses are more detailed representations of hand activity. Unlike the activities, <u>three groups must be selected per window (Position, Movement and Object)</u>. Every time the Position, the Movement or the Object change, a new window must be set and the representation adjusted. You can either annotate all three groups at the same time or one after the other.

<u>Position of the Left Hand</u>

The position of the hand is based on the height to the body.

(1) Above Shoulders
- Position of the left hand above shoulder height.
- The movement up to the shoulder itself does not count. That would be centre.

(2) Centered
- Position of the left hand between thigh and shoulder.

(3) Under Thigh
- Position of the left hand below the thigh.

(4) POSITION UNKNOWN
- Frames that shall not be taken into account, because the pose are not recognisable.
- Also, the subject may be moving outside the camera range

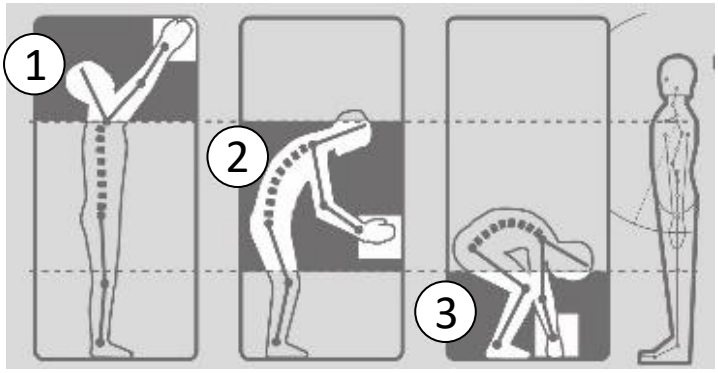


Figure 40: Position of the hand based on the height to the body.

<u>Movement of the Left Hand</u>

(5) Handling
- The left hand handles an object or is in a gripping movement. This means that a handling pose can take place without gripping an object (e.g. if you reach out to grip but change your mind and do not grip an object).
- The handling activities refer to a <u>motion</u>, not to holding onto something

(6) Holding
- The left hand holds an item but does not handle it
- The hand position remains largely unchanged.
  - e.g. holding an order-picking cart while pushing
  - e.g. holding a box while walking
  - e.g. holding an item during the other hand is handling

(7) No Handling and no Holding

- The left hand holds nothing and handles nothing.

(8) MOVEMENT UNKNOWN
- Frames that shall not be taken into account, because the pose are not recognisable.
- Also, the subject may be moving outside the camera range

Object Pose of the Left Hand

(9) No Object
- No object is held or handled in the left hand.

(10) Bulky Unit
- Large object that one cannot put his/her hands around
- e.g. boxes, letter tray

(11) Handy Unit
- Small object that can be carried with a single hand or that one can put his/her arms around
- e. g. screws, nuts, axe, flashlight

(12) Tool
- Holding or handling equipment such as
  - Portable Data Terminal (This include also typing on the screen. In this case, "Screen" (15) must also be selected.)
  - glove scanner (Note: Wearing a glove scanner is not the same as holding or handling)
  - plastic bag
  - bubble wrap
  - tape dispenser
  - knife
  - label
  - shipping list
  - elastic band
  - pen (when used for writing. If a pen is selected as an item, then it is a Handy Unit)
- NOT computer since this is a separate Item Pose (14)

(13) Cart
- Pushing/Pulling the cart to a new location
- Holding the cart

(14) Computer
- Using Mouse / Keyboard

(15) Screen
- Touching Screen e.g. Portable Data Terminal or private smartphone

(16) Button
- Press a button, e.g. on the pick-by-light frame

(17) Onbody
- Touching / handling sensors such as IMUs or GoPro

(18) ANOTHER OBJECT

- E.g. touching the face or the hair as well as touching a bracelet or a wristwatch can be labeled as ANOTHER OBJECT.
- Reason: They are not part of the logical scenario and cannot be assigned to the objects above.

(19) OBJECT UNKNOWN

- Frames that shall not be taken into account, because the pose are not recognisable.
- Also, the subject may be moving outside the camera range

Pose – Right Hand

Poses are more detailed representations of hand activity. Unlike the activities, <u>three groups must be selected per window (Position, Movement and Object)</u>. Every time the Position, the Movement or the Object change, a new window must be set and the representation adjusted. You can either annotate all three groups at the same time or one after the other.

<u>Position of the Right Hand</u>

The position of the hand is based on the height to the body.

(20) Above Shoulders
- Position of the right hand above shoulder height.
- The movement up to the shoulder itself does not count. That would be centre.

(21) Centered
- Position of the right hand between thigh and shoulder.

(22) Under Thigh
- Position of the right hand below the thigh.

(23) POSITION UNKNOWN
- Frames that shall not be taken into account, because the pose are not recognisable.
- Also, the subject may be moving outside the camera range

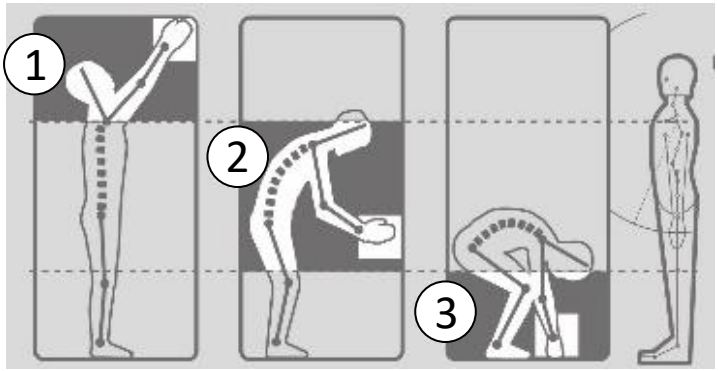


Figure 41: Position of the hand based on the height to the body.

<u>Movement of the Right Hand</u>

(24) Handling
- The right hand handles an object or is in a gripping movement. This means that a handling pose can take place without gripping an object (e.g. if you reach out to grip but change your mind and do not grip an object).
- The handling activities refer to a <u>motion</u>, not to holding onto something

(25) Holding
- The right hand holds an item but does not handle it
- The hand position remains largely unchanged.
  - e.g. holding an order-picking cart while pushing
  - e.g. holding a box while walking
  - e.g. holding an item during the other hand is handling

(26) No Handling and no Holding

- The right hand holds nothing and handles nothing.

(27) MOVEMENT UNKNOWN
- Frames that shall not be taken into account, because the pose are not recognisable.
- Also, the subject may be moving outside the camera range

Object Pose of the Right Hand

(28) No Object
- No object is held or handled in the right hand.

(29) Bulky Unit
- Large object that one cannot put his/her hands around
- e.g. boxes, letter tray

(30) Handy Unit
- Small object that can be carried with a single hand or that one can put his/her arms around
- e. g. screws, nuts, axe, flashlight

(31) Tool
- Holding or handling equipment such as
  - Portable Data Terminal (This include also typing on the screen. In this case, "Screen" (15) must also be selected.)
  - glove scanner (Note: Wearing a glove scanner is not the same as holding or handling)
  - plastic bag
  - bubble wrap
  - tape dispenser
  - knife
  - label
  - shipping list
  - elastic band
  - pen (when used for writing. If a pen is selected as an item, then it is a Handy Unit)
- NOT computer since this is a separate Item Pose (14)

(32) Cart
- Pushing/Pulling the cart to a new location
- Holding the cart

(33) Computer
- Using Mouse / Keyboard

(34) Screen
- Touching Screen e.g. Portable Data Terminal or private smartphone

(35) Button
- Press a button, e.g. on the pick-by-light frame

(36) Onbody
- Touching / handling sensors such as IMUs or GoPro

(37) ANOTHER OBJECT

- E.g. touching the face or the hair as well as touching a bracelet or a wristwatch can be labeled as ANOTHER OBJECT.
- Reason: They are not part of the logical scenario and cannot be assigned to the objects above.

(38) OBJECT UNKNOWN

- Frames that shall not be taken into account, because the pose are not recognisable. Also, the subject may be moving outside the camera range

Main-Process

“Main-Process”, “Order” and “Information Technology” are annotated simultaneously. **It is recommended to select "Information Technology" first,** as the dependencies automatically reduce the choices or select directly the “Main-Process” and the “Order”.

The main process differs in terms of Retrieval (1) and Storage (2). Both main processes start in the office, where the subject receives his order. If it is neither storage nor retrieval, it is ANOTHER MAIN-PROCESS (3). If it is unclear, select MAIN-PROCESS UNKNOWN (4).

Only select <u>ONE</u> Main-Process per window. As soon as the Main-Process changes, a new window must be created.

(1) Retrieval
The entire Retrieval process starts with collecting a picking order and the hardware, continues with order-picking, packaging, handover of packed boxes and return of the hardware.

(2) Storage
The entire Storage process starts with the collection of a storage order, continues with the collection of full boxes, unpacking the boxes and sorting the items, storage the items and delivery of the storage order.

(3) ANOTHER MAIN-PROCESS
The main process can be recognized, but it is not retrieval nor storage
e.g. waiting time between retrieval and storage
e.g. attaching and removing the sensors (IMU)

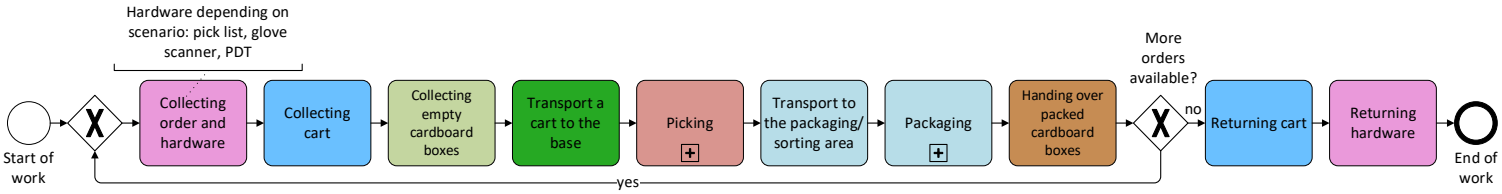
(4) MAIN-PROCESS UNKNOWN
Due to e.g. camera failure, it is not possible to recognize in which main process the subject is participating.

Sub-Process

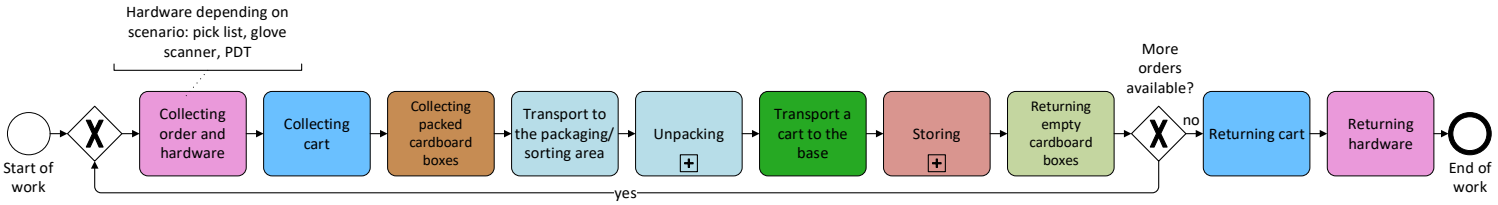
The following Sub-Processes are sorted chronologically according to the retrieval and storage process.

With the dependencies of the previously annotated Activity, Location and Main-Process, the selection options of the sub-processes are sometimes severely restricted. This restriction simplifies the annotation process.

Retrieval

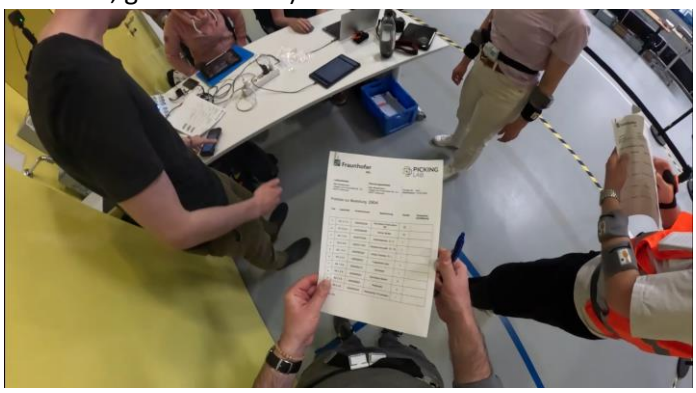


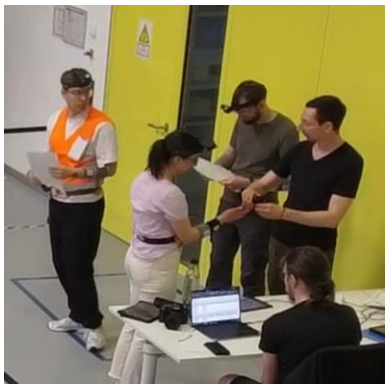
Storing



(1) Collecting order and hardware

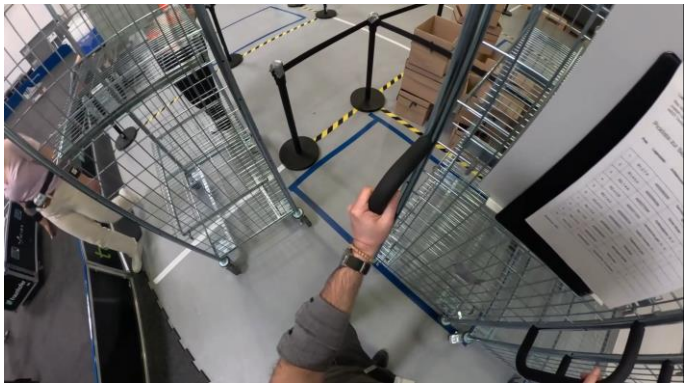
One or more picking orders and the hardware (e.g. picking list, pen, Portable Data Terminal, glove scanner) are collected from the office.





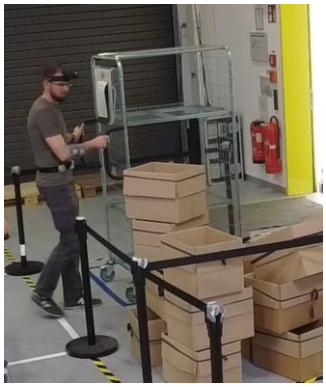
(2) Collecting cart

Collect a cart includes the *path* to the *cart area*, as well as gripping and, if necessary, preparing the cart with a picking list.




(3) Collecting empty cardboard boxes

Picking up empty cardboard boxes includes the *path* to the *cardboard box area* as well as gripping and placing the cardboard boxes.

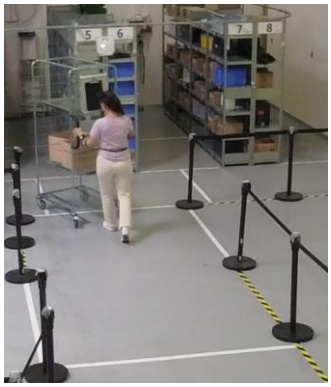


(4) Collecting packed cardboard boxes

Picking up full cardboard boxes includes the path to the *Issuing/receiving area*, searching for the right cardboard boxes, picking up cardboard boxes from a pallet as well as placing the cardboard boxes.

(5) Transport a cart to the base

Transport of a cart to the *base* includes the *path*.



(6) Picking
Picking is subdivided into further processes (see below).

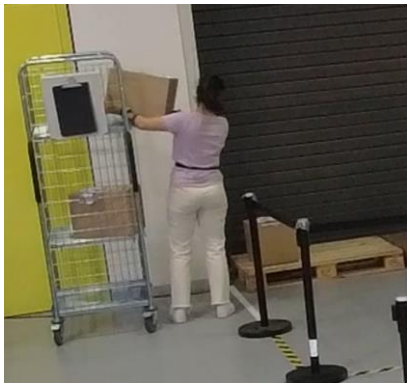
(7) Transport to the packaging/sorting area
Transportation of cardboard boxes, cart or items to the packaging/sorting area. This also includes waiting due to the occupied packaging table.

(8) Unpacking
Unpacking is subdivided into further processes (see below).

(9) Packaging
Packaging is subdivided into further processes (see below).

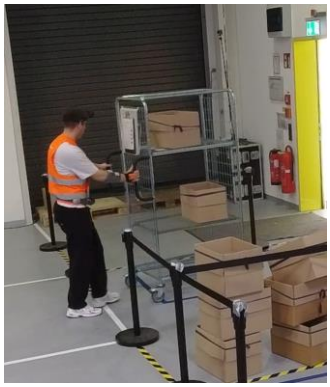
(10) Storing
Stoting is subdivided into further processes (see below).

(11) Handing over packed cardboard boxes
Handing over one or more packed cardboard boxes. This includes also the path to the *Issuing/receiving area* as well as gripping and placing the cardboard boxes.



(12) Returning empty cardboard boxes

Returning one or more empty cardboard boxes. This includes also the path to the *cardboard box area* as well as gripping and placing the cardboard boxes.



(13) Returning cart

The cart is parked in the *cart area*. This also includes the *path* to the cart area.

(14) Returning hardware

The hardware (e.g. picking list, pen, scanner) is returned to the office. This also includes the path to the office.

(15) Waiting

Waiting must be selected if the subject has to interrupt their current process for approx. 100 frames or more.

Waiting has the highest priority. This means that if the person has to wait in the office while picking up the hardware, Waiting is selected for the waiting time. This in turn means that other sub-processes can be interrupted because of Waiting.

An interruption must be clearly recognisable.

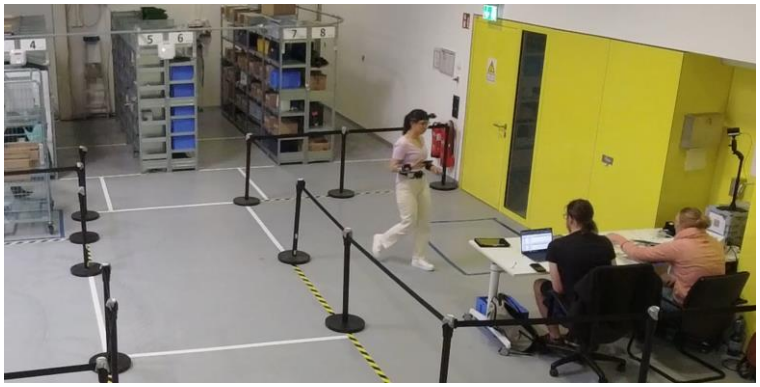
Example:

- Waiting in the packing area because another subject is occupying the packaging table.
- Waiting in the office for a new order or for another subject to hand in the required hardware (e.g. scanner).
- Waiting in the aisle because other subjects are blocking the way.

(16) Report and clarify the incident

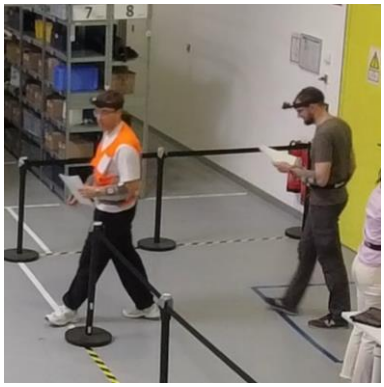
If the subject has questions or discovers errors, these are reported to the people in the office, clarified there directly or clarified in the rack area, packaging area or another area.

The process therefore includes the way to the office, the time in the office, the way back to the rack and, if necessary, clarification with a supervisor at the rack.



(17) Transition

A process is to be labeled as a transition if the movement of the subject is carried out between two different sub-processes, but can theoretically be assigned to both.
Example: If the subject collects the hardware and the picking order from the office (1) and then goes to the cart area to collect a cart (2), the transition is from the time the order is handed over to the time the subject leaves the office. Depending on the interpretation and the focus of the analysis, this transition can theoretically be assigned to both processes (1) and (2).



Transition can also be selected when a new process is started but aborted. For example, on the way to the cart, the subject discovers that he has no plastic bags, so he goes to the office. The path to the put-to-light button and pressing the button can be labeled as a transition. After that, the “Report and clarify the incident” begins.

(18) ANOTHER SUB-PROCESS

The process can be recognised, but cannot be assigned to the previous processes.
e.g. drinking break, synchronisation, sensor attachment, sensor removal, waiting time before the study starts
If the person is texting on their private smartphone while waiting, for example, then it is waiting and not ANOTHER SUB-PROCESS.

(19) SUB-PROCESS UNKNOWN

If the process is not recognisable.

Picking/Storing

(20) Remove cardboard box/item from the cart

(21) Move to next position
Movement to the next compartment. The process ends as soon as the person has reached the compartment. Then "Placing items on a rack" or "Retrieval of titems" begins.
The movement to the next position (for storing and picking), i.e. the next item on the rack to be picked. This also includes checking / matching / reading the information on the list or the Portable Data Terminal. Can also include pressing the pick-by-light button on the way to the position.

(22) Placing items on a rack
The placing of an item on a rack also involves counting the units or checking for correctness.

(23) Retrieval of items
The retrieval of articles begins after the correct storage location has been found and ends with the start of the movement to the next position or to the picking cart.
The retrieval of items from a rack also includes counting the units and putting wrong or to many picked items back in the rack.

(24) Move to a cart
Move to a cart during the picking or storing process. Also includes pressing the pick-by-light button on the way to the cart.

(25) Place cardboard box/items in a cart
Only during Picking.
Although placing a carton can also take place in storing, it is not a planned or desired process step during storing and therefore cannot be selected.

Packaging/Unpacking

(26) Place cardboard box/item on a table
Place the cardboard box or boxes from the cart to a table. This also includes walking from the table to the cart to pick up the box.

(27) Open cardboard box
Opening a closed box, e.g. with a cutter knife. This can happen when unpacking, but also if the return label or an item was forgotten to be placed in the box. During packaging, it is therefore an unplanned process.

(28) Disposal of filling material or shipping label
Only during Unpacking.
Although disposal can also take place in packaging, it is not a planned or desired process step during packaging and therefore cannot be selected.

(29) Sorting

Sorting items during packaging or unpacking.

(30) Fill cardboard box with filling material
The box is filled with bubble wrap. It also counts if the items are wrapped in bubble wrap.
Only during Packaging.

(31) Print shipping label and return slip
The printing process involves going to the computer, using the mouse and keyboard and removing the paper from the printer.
Only during Packaging.

(32) Prepare/add return label
Adding return label in to the box.
Tearing off the return label from the shipping label.

(33) Attach shipping label
Only during Packaging.

(34) Remove elastic band
Only during Packaging.

(35) Seal cardboard box
This includes, for example, folding and taping.
Only during Packaging.

(36) Place cardboard box/item in a cart
The following steps count: lifting the box →the path from the table to the picking cart → placing the box in the picking cart.

(37) Tie elastic band around cardboard
Only during Unpackaging.

Order

“Main-Process”, “Order” and “Information Technology” are annotated simultaneously.

There are three different orders (2904, 2905, 2906). These are either picked or stored one after the other (single-order-picking) or in parallel (multi-order-picking). This applies to the entire main process in which the storage or the retrieval takes place.

You can select <u>more than one</u> Order per window. As soon as the Order changes, a new window must be created.

(1) 2904
Picking or storage Order number 2904. The order contains 15 positions. Each position includes an item that must be picked or stored at least once and up to 20 times.

(2) 2905
Picking or storage Order number 2905. The order contains 15 positions. Each position includes an item that must be picked or stored at least once and up to 20 times.

(3) 2906
Picking or storage Order number 2906. The order contains 15 positions. Each position includes an item that must be picked or stored at least once and up to 20 times.

(4) NO ORDER
e.g. waiting time between two orders
e.g. putting on the sensors

(5) ORDER UNKNOWN
It is not possible to identify whether it is an Order (1)-(3) or NO ORDER (4).
e.g. the subject holds a picking list, but this cannot be clearly assigned to an Order

Information Technology

“Main-Process”, “Order” and “Information Technology” are annotated simultaneously.

Which items need to be picked or stored is transmitted to the picker via a list with a pen (1), a list with a glove scanner (2) or a Portable Data Terminal (3). This applies to the entire main process in which the storage or the retrieval takes place.

Only select ONE Information Technology per window. As soon as the Information Technology changes, a new window must be created.

The “Information Technology” is linked to the “Order” and includes the same start and end frame. As soon as an order begins, “Information Technology” also begins.

(1) List + Pen
Used for the storage of orders 2904, 2905, 2906.
Used for retrieval of order 2904 (single-order-picking) and for retrieval of 2904 + 2905 (multi-order-picking).

(2) List + Glove Scanner
Storage is not carried out with this Information Technology.
Used for retrieval of order 2906 (single-order-picking).

(3) Portable Data Terminal
Storage is not carried out with this Information Technology.
Used for retrieval of order 2905 (single-order-picking).

(4) NO INFORMATION TECHNOLOGY
e.g. waiting time between two orders
e.g. putting on the sensors

(5) INFORMATION TECHNOLOGY UNKNOWN
It is not possible to identify whether an Information Technology (1)-(3) is used or not (4).

Picking and Putting Error

NOT FINAL! UNDER REVIEW!

Each **retrieval AND storage** of an item is checked and labeled accordingly. Between retrievals, i.e. when no retrieval takes place, the item is labeled with IGNORE. The skipping of entire positions or even order pages cannot be labeled during retrieval, as none has taken place. This error can therefore not be marked during retrieval, but must be marked separately.

Only select ONE Picking / Putting Error per window.

(1) NO PICKING / NO PUTTING
There is no picking or putting activity. The "Picking and Putting Error" category can therefore be ignored. This applies to most of the recording.

(2) No error
A picking/putting activity takes place. The pick/put is correct.

(3) Type error
A picking activity takes place, but the item does not have to be picked, according to order.

(4) Quantity error
A picking activity takes place, but the number of units is not correct

(5) Condition error
A picking activity takes place, but the item is damaged.

(6) Skip error
A picking activity is not taking place. An item, i.e. one position, was completely omitted.

(7) Wrong rack compartment
The item is returned to the wrong rack compartment. This also applies if one or more correct items are returned during the same movement.

(8) ANOTHER ERROR
Another picking error that fits either (2), (3), (4) or (5).
e.g. an incorrect item is removed, but the subject notices this error and corrects it. This means that the wrong pick was not carried out to the end.

(9) UNKNOWN
A pick is made, but it is not clear whether it is correct.

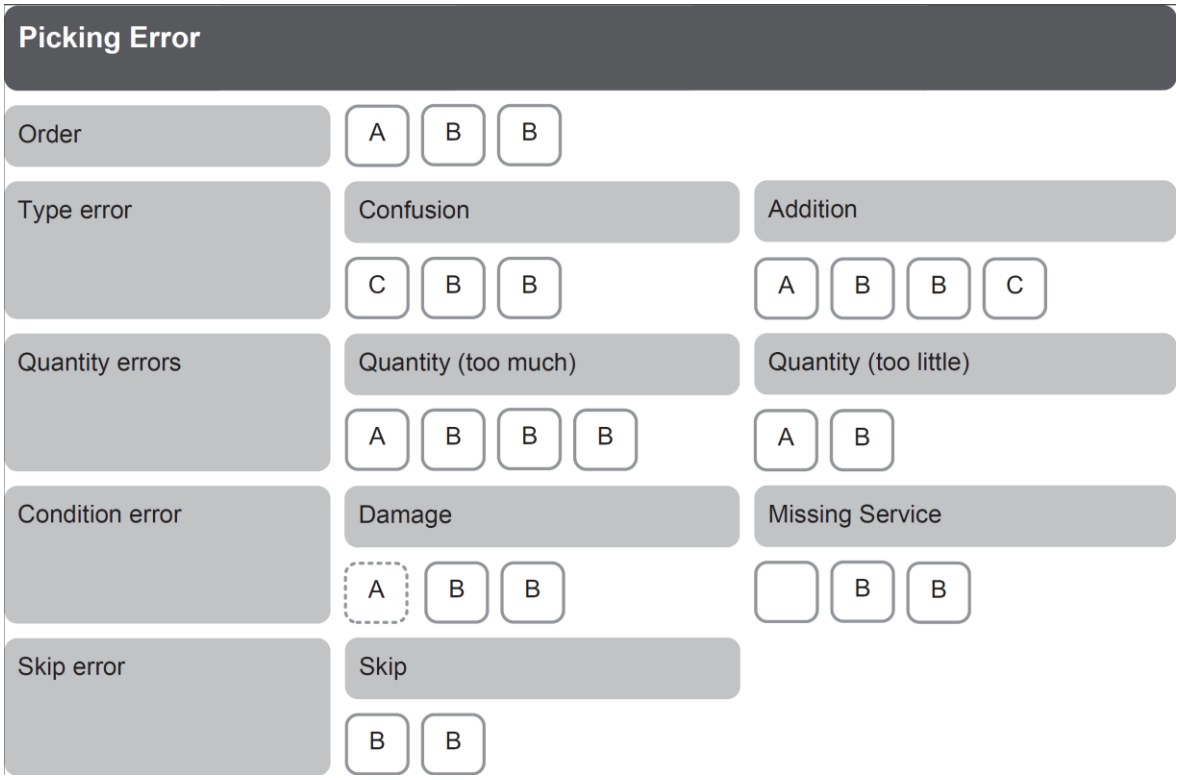


Figure 42: Explanation of picking errors (3) – (6)