

Development of the Elli3 tool for monitoring order picking processes

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Abstract

Order picking is one of the most time-consuming activities in warehousing. Having appropriate measurements and accurate data about the real time-requests of different operations like travel time, searching and picking time or setup time is inevitable for making the decisions about further logistics process developments. These parameters and the correspondence between them can be unique in each warehouse. We are developing the Elli3 tool for this measurement and monitoring purposes in Szabó-Szoba R&D Laboratory at Széchenyi University Győr. The Android-based Elli3.COM program is running on tablet which is extended by a professional barcode reader for the automated identification of locations. In our essay we present the first successful application of the Elli3.com tool at a warehousing company.

Index Terms— order picking, time request measurement

1 Introduce

Very different logistics systems are working all over the world. Almost all of it has an individual process, what requires individual solutions for each problem. Nowadays it is impossible to see the solutions of some problems for managers and engineers, they have to model the problems to find the solving methods.

In the Szabó – Szoba R&D Laboratory we are developing environments on the same platform: analysing and developing the processes according to the technology and real nature of logistics processes (warehousing, picking and layout designing).

Order picking has been identified long time ago as the most labour-intensive and costly activity for almost every warehouse; the cost of order picking is estimated to be as much as 55% of the total warehouse operating expense. Any underperformance in order picking can lead to unsatisfactory service and high operational cost for the warehouse, and consequently for the whole supply chain. In order to operate efficiently, the order-picking process needs to be robustly designed and optimally controlled.

The design of real order-picking systems is often complicated, due to a wide spectrum of external and internal factors which impact design choices. External factors that influence the order-picking choices include marketing channels, customer demand pattern, supplier replenishment pattern and inventory levels, the overall demand for a product, and the state of the economy. Internal factors include system characteristics, organisation, and operational policies of order-picking systems. System characteristics consist of mechanisation level, information availability and warehouse dimensionality. Decision problems related to these factors are often concerned at the design stage. The organisation and operational policies include mainly five factors: routing, storage, batching, zoning and order release mode. The figure also shows the level of complexity of order-picking systems, measured by the distance of the representation of this problem in the axis system to the origin. (Rene' de Koster, Tho Le-Duc, Kees Jan Roodbergen - 2007)

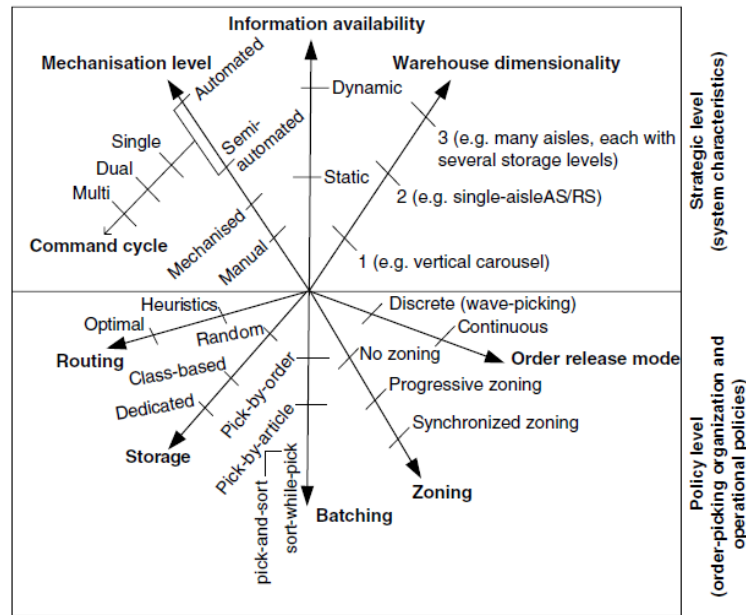


Fig. 1. Complexity of order picking systems (Rene´ de Koster, Tho Le-Duc, Kees Jan Roodbergen - 2007)

Based on these factors we realized the need of integrated performance measurement system for the basic operations in warehousing. In our current developments we designed the Elli3 application.

2 The aim of the measuring system is to determine the basic warehouse activities time requirement

The main goal of the measurement is to assess the time requirement in the basic warehouse logistics process as well as to get measurement dates for the computer simulation program to run which we use in the research and development projects.

These basic operations available in time demands to a large extent depend on the actual physical conditions, characteristics, but the degree of correlation, the individual factors were not known, in different warehouses or in different type of process it is can be substantially different. The measurement perform is indispensable because the simulation program runs during these basic operations occur in great numbers, and if the estimated data its incorrect, the accuracy of the simulation can significantly reduce, or in some cases may call into question the legitimacy of the entire study. (Even with the-second modelling the navigational path regarding the time spent

even if we are wrong order of magnitude for example with the spent time picking each work station or with the waiting time.)

The proper quality and quantity data process, discovering the links can give us proposal to create a measurement method, which can provide us that during the simulation time is able to handle the huge amount of processes with suitable accurate.

The measurement results show in the basic activities (travel, picking, storage position search, ect.) of certain specific time requirement ratio, it is known which operation time request is the highest and which part of the process is necessary to optimize more consideration.

The measured process operation:

- Receipt of goods
- Homogenization
- Store in, upload picking position, over storing to the picking position
- Picking
- Palletisation ,
- Final control

3 The basic warehouse logistics activities related to time require prior assumptions

The previously assumed context in case of the „control type” operations:

- the operation time/processing time depends on the batch number on pallets
- the operation time/processing time depends on the number of units (carton, piece, ec.t) stored on pallets
- the operation time/processing time depends on the other, not to individual articles characteristic parameters such as the number of products, the similarity of collection units, or the complexity of the shape, etc..
- the operation time/ processing time depends on the orderliness of the pile/stack

The previously assumed context regarding to the “loading of goods” processes (homogenization, to storage, order picking, assembling)

- The operation time is depends on the quantity specifics:
 - Number of pieces
 - Collection unit (the collector volume or per unit can be met)
- The operation time is depends on article characteristic
 - Entity/Unit (collectively or pieces) geometrical dimension (volume, aspect ratio)
 - Unit weight
 - Unit manageability, tangibility, etc.
- The operation time is depends on storage space features
 - Storage space level
 - Availability of storage space

The common treatment group based on the analysis of the measurement data to be reviewed. The groups can be separated and new ones can be created.

4 The Elli3 measurement concept

When we got the idea that we need that kind of measurement system first we checked all the national literature on the subject, and after realised/stated that type of storage time required to assess an elementary physical operations automated system had not been so we needed specific improvements.

Our innovation group made a program what is running in Samsung Galaxy S brand tablets and it is a Elli3 Android application. This system is able to measure the time need for the operations of the warehouse and warehouse processes global tracking.

We have several type of measurement applications. The measurement is always compatible with the particular warehouse, warehouse process and special problems. After we realised the problems we can choose which Elli3 measurement applications we need to use for assess the

process and solve the problems. The fact that which Elli3 application we will use it is depend on the special warehouse problem.

Warehouse operations	Measurement applications
Receipt of Goods	Elli3.GIN
Homogenization	Elli3.HOM
Store in, upload picking position, over storing to the picking position	Elli3.MOV
Picking	Elli3.COM
Palletisation	Elli3.PAL
Final control	Elli3.FIN

The most important in the development policy is saving and auto train the time points and intervals. In this case during the data collection the risk is less and the measured dates are saved in electronic form and reliably stored. We have to ensure that the picking list, the item master and measure database are equivalent to each other. The characteristics and quantities of the articles suggest that the parameters such as how they affect the picking time.

The examination of the workflow display-interface adapted to the pre-defined actions appears to be measured - the assessor will tap to activate each key, and the device records the sequence of events with timestamps.

5 Measurements carried out in the picking process Elli3.COM application

The first what we developed it was the picking operation between the warehouse operations. First, because the picking has a high demand of labour, so this operation is the critical area of management resources. On the other hand, because of the international literature in this regard appeared earlier, conventional (non-automatic) measurements were values.

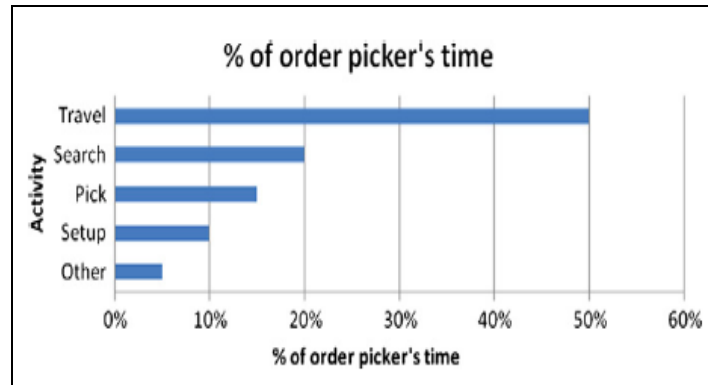


Fig. 2. % of order picker's time -Felix T.S. Chan, H.K. Chan

First we investigated the picking processes to see the global picture, and we made the flow diagram about the process. The exact description of the process played an important role in the preparation of the application.

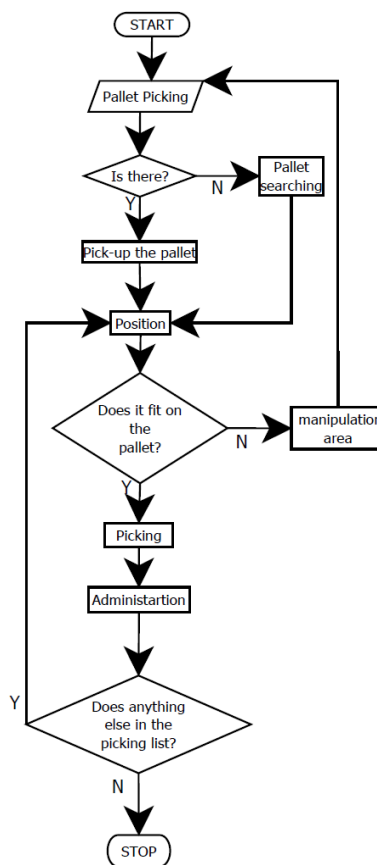


Fig. 3. The picking flow diagram

In the Elli3.COM measurement application we separate the processes about the commonly used terminology: Travel (transport, travel, motion) , Pick (picking), Search (search, identification), Setup (palletisation) and Other.

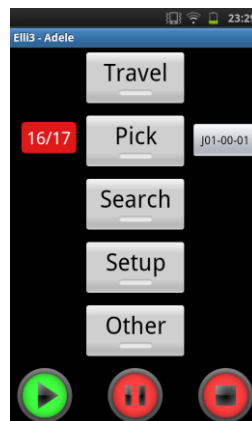


Fig. 4. Main screen of Elli3.COM

The measurement of the time needed for each activity – as shown above – is start with touching the operation button. The current valid re-touch action buttons to pause the measurement. Touch to any other action buttons to stop and logging (time stamp) to the previous event, and assigned to that button starts the stopwatch timer.

The measured dates are always in a *.Csv extension to fill will be saved, which is formed when the applications is started. The file name is include the showed the time when you start the measurement.

PLAY-PAUSE-STOP

- Always start the measurement by pressing the Play button
- With press the play button the picking list extracting time will be recorded

- It is appropriate to use, if the measuring person make an mistake during date capture (for example he forget to push the picking button, he made an error he pushed the wrong button, ect.)
- When you touch the pause button the Csv files will stopped automatically and when you will touch the play button new Csv file will start. (file name will be quite the same just the new file name will get an “-2” number on the end.
- To stop the measurement process you have to press the Stop button
- The related operations Csv and Barcode Csv files are prepared and closed

RECORD

Voice record function

- During the picking is something irregular happening , the assessor person has to push the record button to record the voice, and he have to tell everything about the irregular event because it is important in the evaluation.
- To stopped the record you have to touch one more time the record button
- The files are saved with time stamp into the measuring device memory, so the valuation of the picking task can assigned clearly

BARCODE/PICKING RATE

The fixed/recorded Pick operation and the scanned barcodes are matching the number of function

- When the measurement of the measuring device is connected to a bar code reader, the device is able to read directly from the meter's memory to the picking position code (you do not need the pick list to record the copy of the order picking)
- The green colour of background is means matching, while the red background varies Pick the fixed operations and the scanned barcode number
- The data needed to update from 0.5 to 1 sec

PAUSE

The pause the measurement if it is necessary

- It is appropriate to use, if the measuring person make an mistake during date capture (for example he forget to push the picking button, ha made an error ha pushed the wrong button, ect.)
- When you touch the pause button the Csv files will stopped automatically and when you will touch the play button new Csv file will start. (file name will be quite the same just the new file name will get an “-2” number on the and.

DELETE THE LAST BARCODE

If we read a wrong barcode with that function we can correct it easily.

- The label/title of the button always shows the last read barcode – if the measurement person realized that he had read the wrong bar code, he push the bar code button and deleted it, after he can correct the error and read the right barcode.
- To update a process it is need 0,5-1mp

After the measurement we can conclude the followings:

- The allocation of the time consumption
- Frequency of basic operations
- Create statistical indicators according to the clusters (mean, median, mode, range, standard deviation, variation)
- Observe palletisation specificity
- We can evaluate and esteem of time-consuming of each picking operations

6 The measurement Process

Start the measurement

- Always start the measurement by pressing the Play button

The Play button is pressed, the picking list, extracting starting time will be recorded

Identification of the elementary picking process

Travel

- Travel, transportation between the time spent picking positions - Pressing the button once to start operation, travel shows, any other operation button will automatically mean the end of the operation, Travel
- The start of the operation when the machine start to the picking area to halt until the target position

Search

- Usually is recorded after the Travel button, but it may happen that with one stop the picking person can pick two or more items so doesn't have to move the jet because the picking positions its really near each other.
- The search operation start with the identification of picking position and ends with the collecting products ID.

PICK

- Normally, the Search process begins with the completion of the last pallet put into picking product lasts
- When the picking warehouse colleague has a space and staff product knowledge thanks to the Search operation is very short (less than or completely), it may, after the operation Travel - Search for skipping - Pick will be recorded
- The picking of the tablets recording the position data via Bluetooth barcode reader attached to Pick validation process takes place after that.

ADMIN

The time needed for administrative task for the picking person

- Administrative task can be indication of the performance of the picking list or includes the study of the pick list to select the next picking position
- The admin process is start when picking person pick up a pen and finish when put down for his hands the pen and the picking list
- Equally important to record the time needed for administrative tasks - these tasks can be marked in the performance of the picking list or pick list includes the study of the next picking position to select

OTHER

- Here are recorded the previous operations not falling within the scope of activities, such as the inclusion of pallets or pallet placement of the manipulation of the collected background

SETUP

- The time what you spent with the palletisation and rearrange stack

Completion of the measurement

- The measuring process – specified picking list – to stop the measurement you have to press the stop button.
- The operation Csv and the Barcode Csv which are belong in the same task of picking are completed and are closed.

7 Data Processing

7.1 The registered files when Elli3.COM application is running

The Elli3 software records the time-stamped data to the dedicated folders on the tablets by three forms:

- start and duration of the operations edited by the touchscreen (TRAVEL, SEARCH, PICK, ADMIN, SETUP, OTHER, in 'csv' extension)
- the involved storage IDs during the picking is sent by barcode readers via bluetooth connection (in 'csv' extension)
- specific additional information - needed for later evaluation (in '3gp' format)

The evaluation is based on the following measurements:

Code	Date	Functions, developments
D01	05/23/12	Measurement test: TRAVEL, SEARCH, PICK, SETUP, OTHER buttons
D02	06/06/12	Elli3.COM screen modifications
D03	06/08/12	Harmonized measurement protocol design, recording
D04	07/12/12	Introduction of the barcode reader function
D05	08/06/12	Measurement test: Voice Recorder Function ('3gp'), adding 'Admin' button
D06	08/08/12	Measurement test with Elli3.COM application
D07	08/15/12	Measurement test with Elli3.COM application

7.2 Sorting the input data

- The created files (picking list) by Elli3.COM application (processes and positions codes) are copied to a worksheet
- We filter the picking operations in a separate column and colligate with the appropriate storage IDs from the list registered by the barcode readers (in case of divergence we clarify with the help of voice files and printed picking lists)
- We assign the paper based invoice codes with the appropriate worksheet
- We transform the received data tables for further processing (clustering and processing input data)

7.3 Comparison of the proportions of picking operations

- sum up the time spent on each elementary operations, and the occurrence of operations, sort by the picking lists into a tables

- The following graphs are created:

The left graph shows the time-consumption, the right shows the frequency of elementary operations.

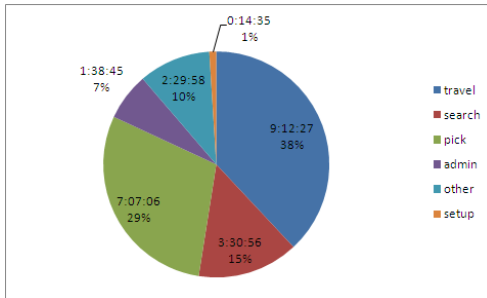


Fig. 5. Elli3.COM Time-share of elementary operations

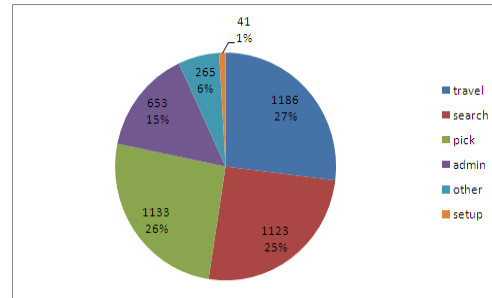


Fig. 6. Elli3.COM Frequency of elementary operations

- The proportion of PICK/SEARCH, SEARCH/PICK, PICK/ADMIN and ADMIN/PICK operations are demonstrated on the bar graphs below.

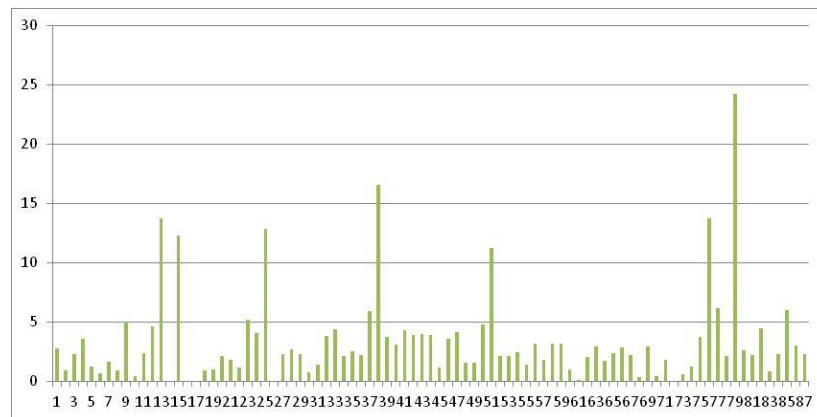


Fig. 7. PICK/ADMIN proportions

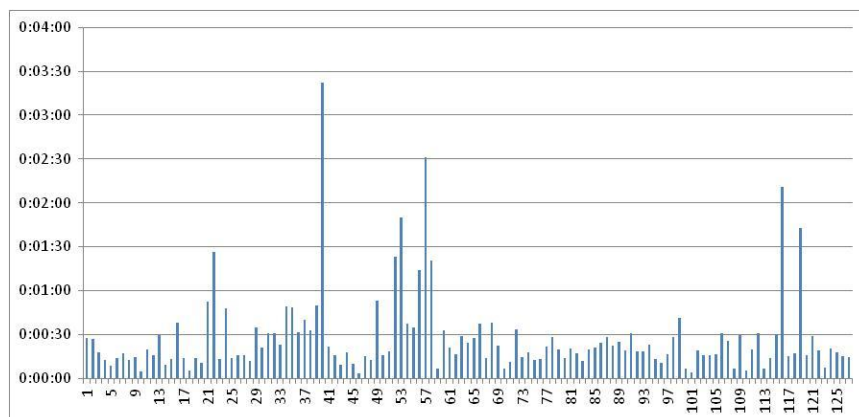


Fig. 8. Average PICK time

7.4 Partition

- We arrange the duration of operations in a summary worksheet
- We sum up the occurrence of each operations
- The graphs show the allocations of particular operations

For the better understanding we transform the tablets into the appropriate scales

- For example the green cell shows the PICK operation with the duration between 5-10 seconds has been registered 230 times

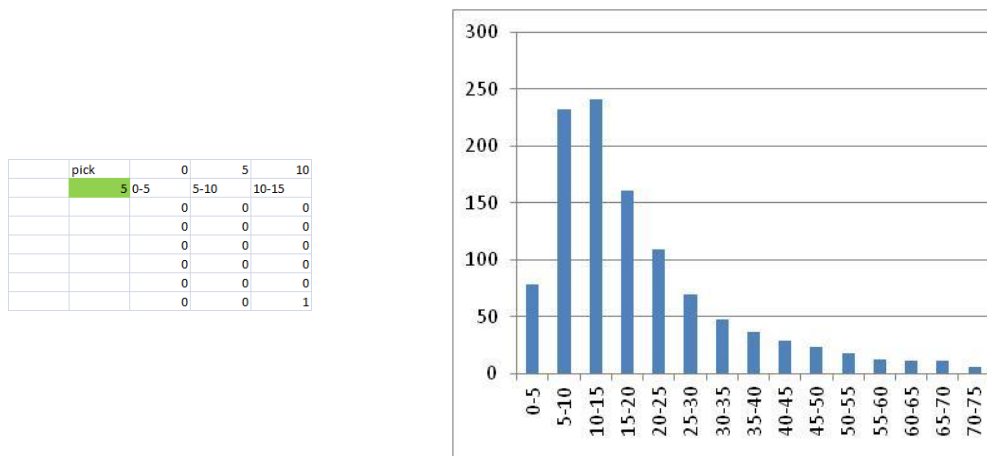


Fig. 9. Allocation of time-consumption in PICK operations

7.5 Forming typical operation clusters

- We form the clusters based on the quantity and weights for analyze the picking specification
- We integrate the different weights and the palletisation properties into the list of item numbers (the database we received from the partner)
- Sum up the total moved mass in kilograms by picking tasks
- We perform the clustering with the method described in the previous paragraph considering the number of items and the mass
- Using the database functions we create statistical indicators according to the clusters (mean, median, mode, range, standard deviation, variation)
- From the obtained value we form a 3D graph:

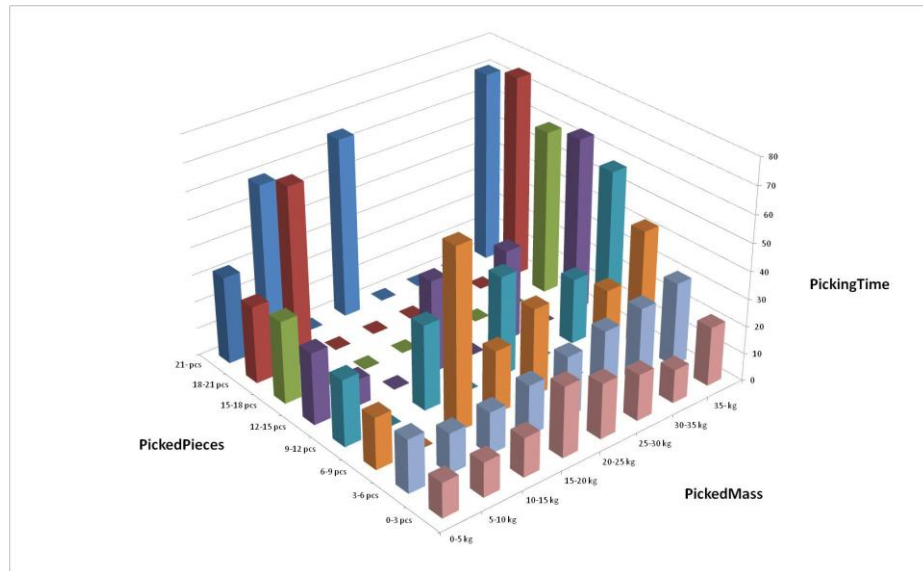


Fig. 10. Average picking time value by the recorded clusters regarding to the collected quantity and total weight

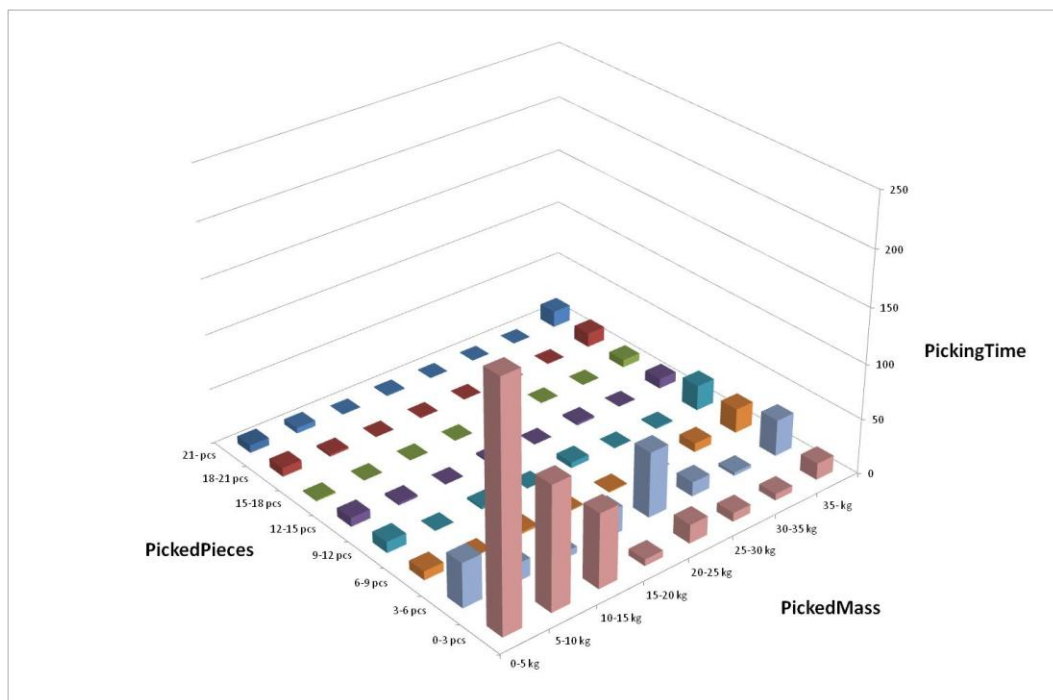


Fig. 11. Amount of measured data in clusters

8 The further application development Elli3

We saw how important inquire into the warehouse processes so we started improve the other processes. After the picking process measure Elli3.COM application we start to deal with final control process which is Elli3.FIN application.

First we made the final control flow diagram:

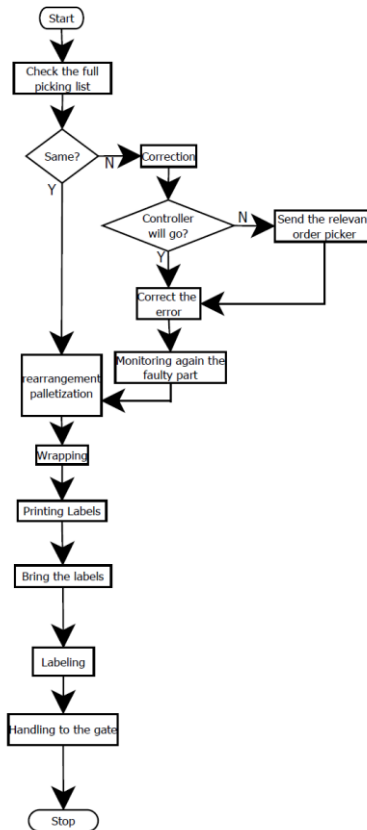


Fig. 12. Final control flow diagram

The development project can be significantly accelerate with each warehouse operations are clearly defined in the flow charts. If it is correct and clearly defined we can work on the applications.

9 Conclusion

After recognizing the absence of an integrated performance measuring application on the field of warehouse operations we created the Elli3 software group. During the scientific literature researches we realized the extensive aspects so at the beginning of the development we focused on the basic properties of warehouses. In this base we implemented the specificities of warehousing operations (receipt of goods, homogenization, store in, upload picking position, over storing to the picking position, picking, palletisation, final control). During the software development we tested continuously the application until it reached the actual form. This version is appropriate for applying the changes regarding to the industrial partners' requirements.

So far the tests has proved the results of the scientific literature the travel has the proportion amount the basic warehousing operations. Therefore we should focus on warehouse layout in order to decrease the travel time and cost.

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