

Development of computer simulation tools for the WaNDa Ruta interactive plotting board

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Abstract:

Modelling and simulation is the only objective way to compare different alternatives of logistics solutions in warehousing. Computer simulation tools have attractive promises, but it is always a problem to decide which elements and factors we should consider or we can neglect. In the frame of the WaNDA Ruta trainings participants get real-life experience about the importance of choosing the appropriate product arrangement layout and order picking strategy on the learning-by-doing way. As an interactive plotting board is a very efficient environment to support the participants being familiar with warehousing. The number of investigated cases is low, because of the duration time of the training. We are working on the development of computer simulation tools to extend the number of cases affected – like it is one of the best ways to develop the computer skills of participants on this field of logistics.

Index Terms— warehousing, training, computer simulation

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1 IMPORTANCE OF MODELLING

Modeling logistics systems make us possible to learn the logistics way of thinking, to discover problems and bottle necks of processes. Furthermore this is the only objective way to find optimal and adaptive solutions. This is a connection of the theoretic and practical thinking of engineering logistics systems. The different modeling equipments make us possible to test many alternatives on the cheapest way. In this case we should not invest in trying different ideas or solutions; we can check it in mobile individual environment. In the practice the most known modeling method is the computer simulation. Plotting board simulation is unique and can provide innovative way to our partners.

2 MODELLING ALTERNATIVES

2.1 Plotting board based – advantage, disadvantages

The plotting board modeling methodology is constructed for simplified processes and layouts based on real systems, algorithms and database. The physical model and the learning by doing method provides inner view point for the participants, they are active parts of the processes. The variable plotting boards can be also combined with informatics systems, what make as possible to simulate all kind of logistics processes. With the help of interactive environments it is easy to explain the logistics problems and solutions, so the participants believe it's functionality and advantages.

Besides this method has some weaknesses in spite of simulation. Sometimes you may need more complex area for modeling, plotting board is only able to show very simplified environment. Because the participants are involved into the process, it can happen, that they are lost in the details and it is difficult to see the processes with the eye of an outsider, consider the whole complex chain as one process.

2.1.1 Computer based – advantage, disadvantages

The computer simulations make us possible to model whole complex logistics systems based on mathematical, statistical methods and algorithms. Parametric structure and refreshable database help to synchronize the model with the actual situation for each project. The system can continuously collect statistics and generate charts in real-time, which data mean the basis of the comparisons of alternatives. One of discrete event simulation tool is the Tecnomatix Plant Simulation, which framework supports the model designing by existing objects and methods. The

object oriented and programmable structure is flexible enough to model all kind of individual processes, strategies, algorithms. Although visual equipments of the simulation frameworks are continuously and quickly developed, the partners get external viewpoint of the systems and solutions. The passive participants usually cannot believe the solutions, because they do not see the depths of algorithms and solutions. Furthermore it is an expensive way of modelling and requires deep computer skills.

2.2 Plotting board based modelling in the WaNDa environment

WaNDa (Warehouse aNd Distribution) is an extremely interesting and representative model for logistics students and experts to learn and understand relations and coherencies in supply networks and warehouses. Operational efficiency of the companies is strongly affected by the design decisions, but it can be very expensive or impossible to change the design decisions once the warehouse is actually built. WaNDa environments are able to demonstrate all the impact of these decisions on the overall warehouse performance.

Order picking has been identified for a long time as the most labour-intensive and expensive activity for almost every warehouse: the cost of order picking is estimated to be as much as 55% of the total warehouse operating expenses. 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. [Rene' de Koster, Tho Le-Duc, Kees Jan Roodbergen, 2007] The design of the 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.

The order picking time is influenced mainly by moving, searching, picking and unit load building time. The most crucial parameter is the travelling time, which gives 50% of the whole picking time.

3 WANDA RUTA

For the first version of the simulation of warehouse processes we used a classroom at the university, boxes for the storage on the different positions and lego parts as products. We usually had 8 participants (order picking operators) and 1-2 observers.

In the warehouse are six corridors. In every corridor there are four boxes with the products. The first layout of the products was random.

YW12	BE11	RD12	WE24
RD22	WE11	GN22	LN22
RD24	BE22	BN12	WE22
OE12	BE12	BK22	BE24
YW22	BK12	LN12	GN12
WE12	RD11	OE22	YW11

Figure 1: Initial layout

We worked with eight order list.

OrderID	ItemNo	Qty	OrderID	ItemNo	Qty	OrderID	ItemNo	Qty
1	BE12	5	2	GN12	3	3	BE22	3
1	BE24	1	2	RD11	3	3	BE11	1
1	BE11	2	2	BK22	2	3	LN22	2
1	BK12	4	2	BE12	4	3	GN12	4
1	WE12	5	2	WE11	2	3	BE12	6
1	GN12	3	2	WE12	4	3	LN12	2
1	YW22	3				3	GN22	3
1	LN22	3				3	WE11	2
1	GN22	3				3	WE22	2
						3	WE12	4
OrderID	ItemNo	Qty	OrderID	ItemNo	Qty	OrderID	ItemNo	Qty
4	BE12	5	5	YW12	6	6	YW11	2
4	BK12	5	5	YW22	3	6	BE24	1
4	WE12	5	5	RD12	6	6	BE11	1
4	WE11	2	5	OE12	4	6	BK22	2
4	YW12	6	5	GN22	2	6	YW12	6
4	LN22	3	5	WE24	1	6	RD11	3
4	BE22	4				6	WE22	2
						6	GN22	3
OrderID	ItemNo	Qty	OrderID	ItemNo	Qty			
7	LN22	3	8	WE24	1			
7	YW22	4	8	WE12	5			
7	WE12	4	8	OE12	4			
7	GN12	4	8	BN12	4			
7	RD12	4	8	RD12	4			
7	OE22	3	8	YW11	3			
7	BE24	2	8	GN12	4			
7	YW12	6						

Figure 2: Picking lists

On the Figure 3, we can see that the 3. and the 4. participant starting from the end of the warehouse and the others from the beginning, in this case we are able to avoid the traffic jams. After all We have chosen a different routing optimization method. We checked the times pay attention for the longest ones, and the meeting points. We have chosen the 3. participant, because he has to go for another round to avoid the stuck. The other participant who was selected by this method was the second one, because he has the shortest route. In this case he will be the first, as a result probably he will not cause traffic jams.

On the Figure 4. We investigated the touching points with the most heavy traffic. From this point I send the couple participants for the other positions, and gave them different picking order.

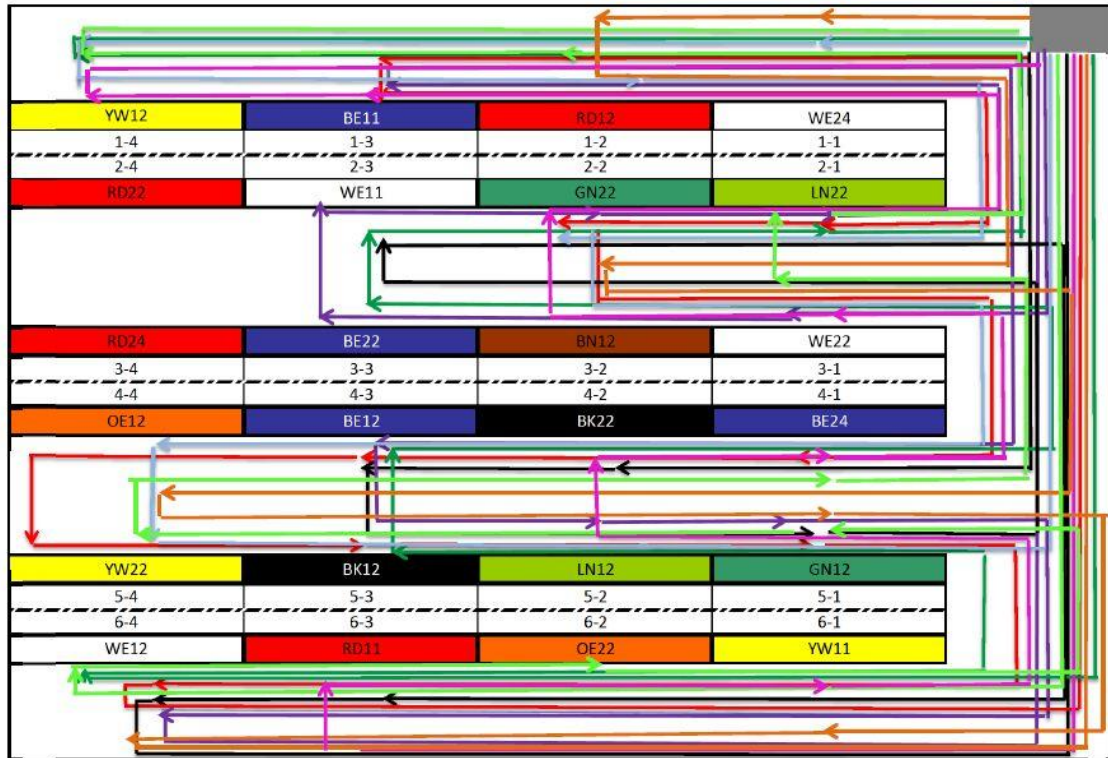


Figure 3: Example for initial picking routes

3.1 Disadvantages of initial layout:

- too much travel
- unsystematic location
- traffic jam

Solution:

Products with fast velocity at the end of the corridors

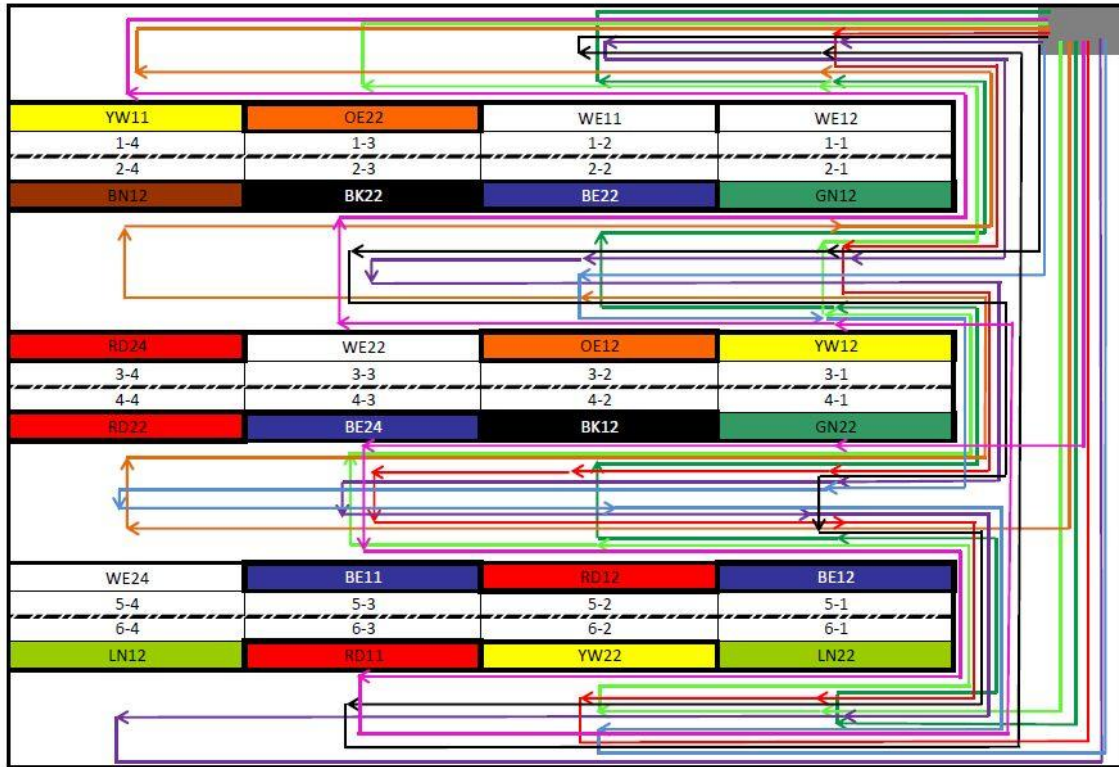


Figure 4: Example for velocity based picking

First round:

- Nearly everybody began the search in the first line
- nearly the same way of searching
- too much waiting time at some products
- traffic jam
- long process time

Second round:

Not everybody began the search in the first line. Four operator began the search at the last one. The time of the processes was shorter, but there were traffic jams in the middle lines.

Third round:

Three operators began the search in the first line, three operators began at the last one, and other two operators began in the middle of the lines.

- Not so many traffic jam
- the time of the processes were shorter

If we have got so many products, than this is the best solution.

3.2 Zone picking

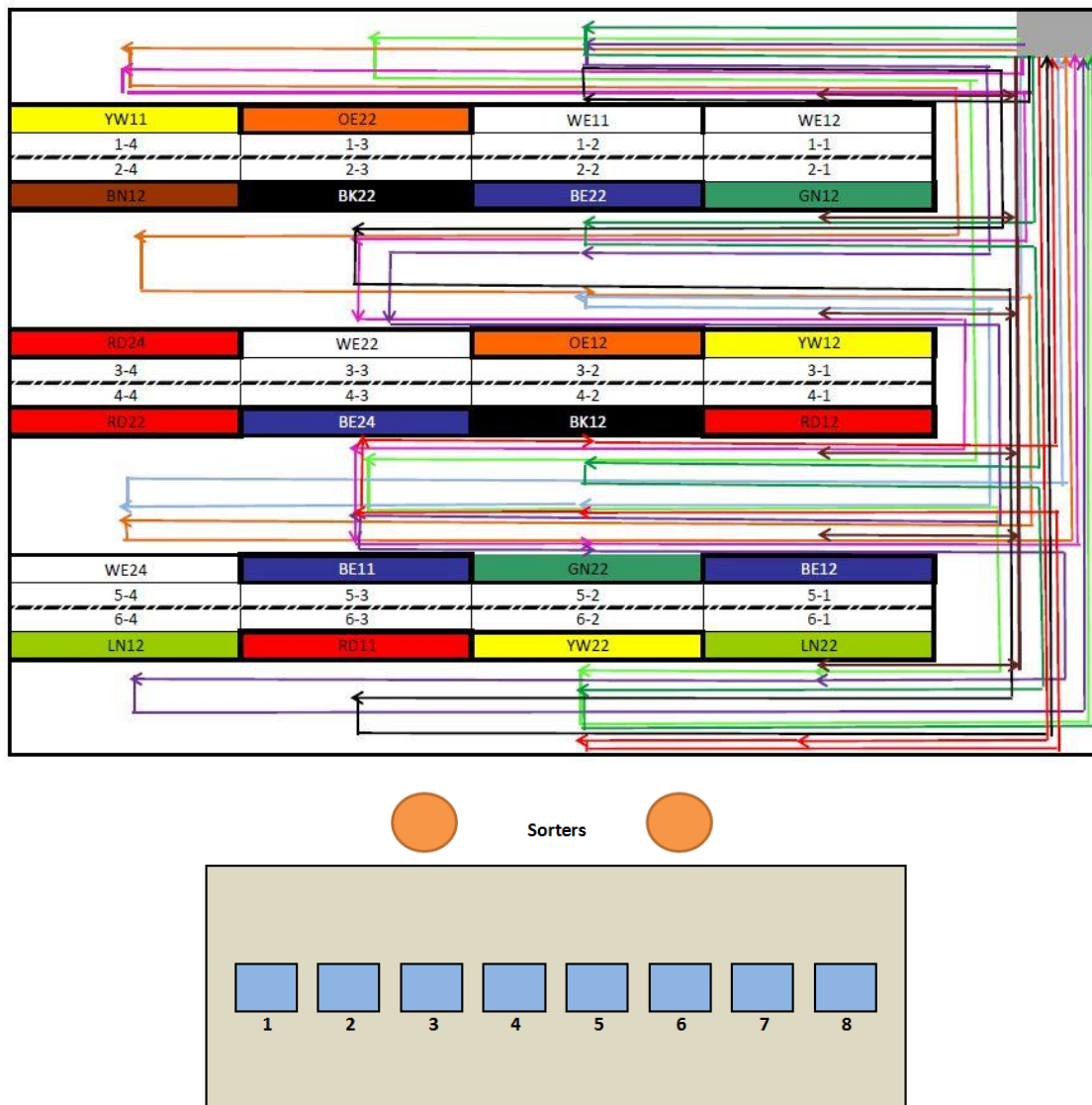


Figure 5: Zone picking layout with manipulation area

Collection according to zone

The first step we decided the products which we want to pick and whom. Than we planned the layout. The next step was direction of the process. The last step was the administration.

We pick the 6-1 product for collector, and other product (5-1, 4-1, 3-1, 2-1, 1-1) for customer. We decided that we exchange 5-2 product with 4-1 product.

The product of collector:

- WE12 - 27 pieces
- GN18 - 18 pieces
- YW12 - 24 pieces
- RD12 - 14 pieces
- BE12 - 20 pieces

The collector picking pick these product, the customer picking pick the other products. The customer picking collected 2-2 order. There were sorters, who assorted the product, which the collector picking collected and brought at the collecting place. So we must work up the stand apart place, where the winnowings happend.

We need the pearson, who watched the product, that when arrived at the collection point.

Summary, we need:

- Two sorter
- One collector picking
- Four customer picking
- + one person, who watching the process

4 EXPERIENCES

The first round: The sorters were bored, because the first product of collector arrived slowly. The fastest order get ready under 2:25 minutes, and the slowest order get ready 4:16 minutes.

The second round: We experienced that the first solution wasn't good, because the sorters waited for collectors. Therefore in this round, they (sorter) collected the first two product(1-1, 2-1). The collector picked the other product. In this way the process was quicker. The fastest order get ready under 2:06 minutes, and the slowest order get ready 2:28 minutes.

5 PLANT SIMULATION MODEL VISION OF WANDA RUTA

Requirements of the WaNDa Ruta Plant Simulation model:

- Able to model all kind of solution, what the participants find in the plotting board model.
So It should be highly parameterized and flexible
- It has to be in conformity with the plotting board model. It is required to the participants can compare the solutions and solutions

Input data of the model

- Scaled layout based on the real WaNDa Ruta model
- Generating method of the orders and also manually defined orders
- Processes based on changeable parameters

Main elements

- Frame of the global variables/parameters
- Position objects
- FootPath objects
- Manipulation area
- Workers

Some required parameters

- Global parameters
 - Number of pickers
 - Number of picking list
- Parameters of position objects
 - Position Code
 - Dedicated product
 - Initial stock
- Parameter of FootPath object
 - Active or inactive foot path. It make us possible to model different kind layouts (i.e.: head layout, throughput layout...)
- Parameters of manipulation area
 - Buffer positions and position code
 - Initial number of SKU

- Parameters of the pickers
 - ID of the picked lists
 - Routing of each list
 - optimization by the simulation – further development

6 VISION OF THE MODEL FUNCTIONALITY

- Possible running mode
 - Start with fix picking list. It make us possible simulate the same list than in the plotting board model
 - Continuously generated lists. Good to try different solutions with high number of lists.
- The defined workers pick their each list.
 - Walk to the position
 - Pick the required quantity – wait the counted time
 - Next position
 - Store to the manipulation area
 - Start next list
- During the model running the simulation continuously collect statistical data and raw data to the later analysis
 - Walked distance of each picker
 - Time of picking
 - Shankey diagram
 - Crowded points

7 ACTUAL FUNCTIONALITY OF THE RUTA COMPUTER BASED SIMULATION

Goal of our actual model is to measure the distances of picking routes on all kinds of layouts.

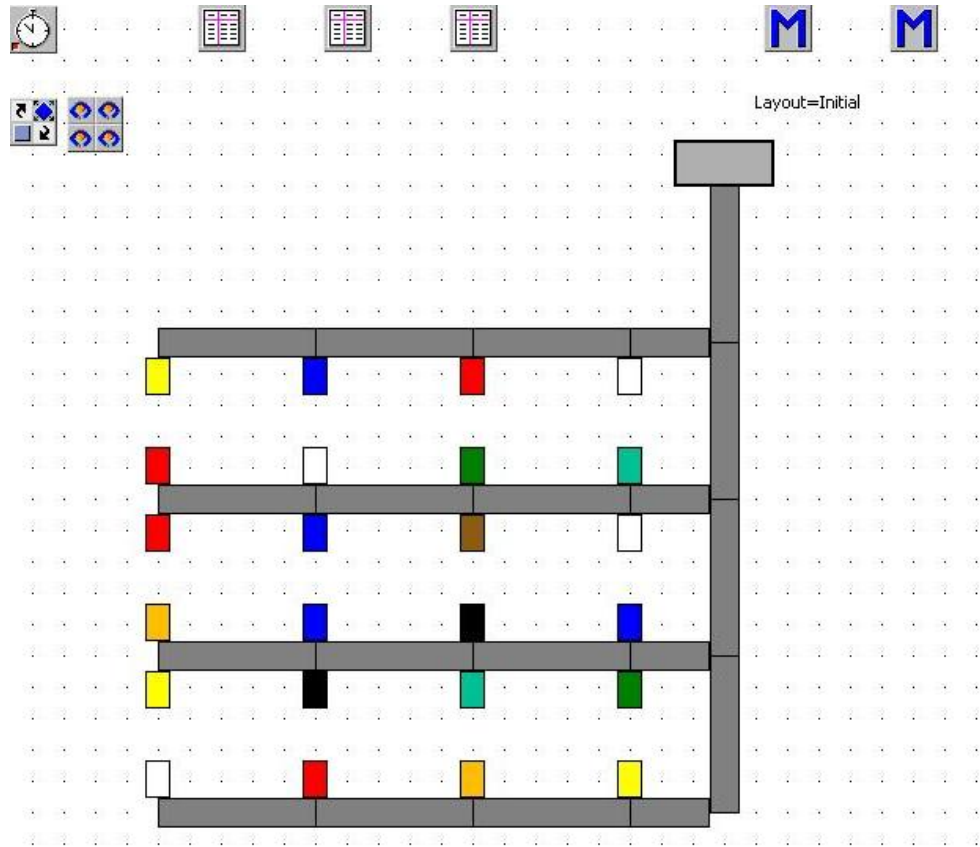


Figure 6: Simulation model

We can set:

- Different product dedications
- Routings of different picking lists

Working steps

- Chose layout variation
- Run calculation method

	string 0	object 1	string 2	string 3	string 4
string	Pos	Object	ItemInitial	ItemVelocity	ItemZone
1	1-1	*,Models,WaNDa,PosOrig11111111	WE24	WE12	WE12
2	1-2	*,Models,WaNDa,PosOrig11211111	RD12	WE11	WE11
3	1-3	*,Models,WaNDa,PosOrig12111111	BE11	OE22	OE22
4	1-4	*,Models,WaNDa,PosOrig211111	YW12	YW11	YW11
5	2-1	*,Models,WaNDa,PosOrig1111	LN22	GN12	GN12
6	2-2	*,Models,WaNDa,PosOrig1111	GN22	BE22	BE22
7	2-3	*,Models,WaNDa,PosOrig1111	WE11	BK22	BK22
8	2-4	*,Models,WaNDa,PosOrig1111	RD22	BN12	BN12
9	3-1	*,Models,WaNDa,PosOrig111111	WE22	YW12	YW12
10	3-2	*,Models,WaNDa,PosOrig111211	BN12	OE12	OE12
11	3-3	*,Models,WaNDa,PosOrig121111	BE22	WE22	WE22
12	3-4	*,Models,WaNDa,PosOrig211111	RD24	RD24	RD24
13	4-1	*,Models,WaNDa,PosOrig111111	BE24	GN22	RD12
14	4-2	*,Models,WaNDa,PosOrig112111	BK22	BK12	BK12
15	4-3	*,Models,WaNDa,PosOrig121111	BE12	BE24	BE24
16	4-4	*,Models,WaNDa,PosOrig211111	OE12	RD22	RD22
17	5-1	*,Models,WaNDa,PosOrig111111	GN12	BE12	BE12
18	5-2	*,Models,WaNDa,PosOrig112111	LN12	RD12	GN22

Figure 7: Input table of layouts

	string 0	string 1
string	OrderID	ItemNo
9	1	GN22
10	2	GN12
11	2	RD11
12	2	BK22
13	2	BE12
14	2	WE11
15	2	WE12
16	3	BE22
17	3	BE11
18	3	LN22
19	3	GN12
20	3	BE12
21	3	LN12
22	3	GN22
23	3	WE11
24	3	WE22
25	3	WE12
26	4	BE12
27	4	BK12
28	4	WE12

Figure 8: Input table of picking lists

The Result table show the measured distance of each order picking list

	string 0	length[m] 1
string	OrderID	Distance
1	1	44
2	2	35
3	3	40
4	4	39
5	5	38
6	6	43
7	7	44
8	8	37
9	9	38.5
10		
11		

Figure 9: Result table of the simulation model

We are able to compare different routing variation based on distances; this is one of the most important factors of the order picking process. (Felix T.S. Chan, H.K. Chan - 2011)

8 SIMULTANEOUS USAGE OF COMPUTER BASED SIMULATION AND PLOTTING BOARD

Simultaneous usage makes us possible to complete the two kind of modelling method. So we can reach the synergic effect of the modelling cooperation.

Usage of the plotting board model:

- This interactive environment great to generate innovative solutions during brainstorming
- Demonstrate solutions on the learning by doing way, the participants will understand the solutions
- The modelled processes are measureable and appreciable
- The participants feel how optimal is the actual process

Usage of the computer based simulation:

- Previously well built and parameterized simulation can model each kind solution what the participants performed in the plotting board. So the simulation can evaluate the solutions
- The computer based simulation run faster than the interactive plotting board simulation. So it is possible to try more alternatives and after demonstrate it in the plotting board

9 CONCLUSION

Order picking operations play key role in warehousing. To solve the contradictions and trade-offs on this field modelling and simulation is the only objective way. In our essay we have presented the WaNDa Ruta environment, like a possible frame and tool to demonstrate and develop warehousing logistics processes. Recently is the simulation applicable and suitable for the WaNDa Ruta environment. The future development direction is a model with racks, expansion to the other WaNDa plotting boards.

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