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Introducing a Model in Order to Logistics Balance with the Aim of Improving for Total Expected Cost
(Case Study: Tondar 90 Assembly Shop – Iran Khodro Co)

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ABSTRACT

In this article based on case study in Tondar 90 assembly shop in Iran khodro company, with the use of "Stop -Watch" method, the cycle time of every conveyance operation to each workstation of the assembly lines is measured then the standard time of every conveyance cycle, the ideal rate of conveyance, the velocity of conveyance in each minute, are calculated. Then, with the use of linear programming technique, decrease the total expected cost of conveyance. In the next stage, by using the Hungarian allocation technique, for each line of assembly shop, lifter and the operator was allocated and in the next stage with the use of distinction criterion ranking technique, the optimum mix of lifters related to the type of identified application in the whole shop, determined. Finally with the use of 'technique for order preference by similarity to ideal solution' (TOPSIS), the best conveyance operator, technically the best performance of conveyance as for specified indexes, is characterized.
KEY WORDS: stop-watch, linear programming, total expected cost, logistics, balance.

INTRODUCTION AND PROBLEM STATEMENT

These days, daily increasing of competitive conditions in markets, customer services and essential progress in information technology and communication industries caused to satisfying the customers in appropriate quality of product or service, low price in comparison to other competitive and on time delivery of product or service, has the essential role in remaining of organizations at markets and getting the market's proportion. For this reason the concept of supplying chain management is posed during these two decades.

Logistic balance issue is an assurance for being equal of loading operation times and transferring a loading or unloading considering to production rate which is result of ideal transferring rate. Ideal transferring rate is converted to the transferring time of each part which is named such as balance index or balance time or cycle time.

Balancing the logistic operation is caused to allocating the optimum required operators in logistic process, determining the optimum transferring time, and decreasing the total expected cost of transferring operation of materials and other stuff during the building stream. Finally, this is caused to increasing the velocity of supplying parts according to the production plan and non-stopping in the production process and rapid respond to the receiving requests. In this research we are looking for considering that weather balancing logistic through the application of suitable blend of the number of the human resources and transferring instruments in assembly shop, could be useful in improving the costs of transferring or not? And if this claim will be true, in which different parts of logistic, exclusive of internal logistic, with the use of logistic balance, could be used.

Much research has been done in this issue, some of which that: with the aim of developing a phase multi-purposed model for equalizing the use of transportation machines in logistic system, have considered this issue (Ghazanfari, khalili-dizaj, 2004). Was choosing as case study with the purpose of decreasing the transportation costs in iran khodro Company (Asghari, Aghdasi, 2004). Have presented a model for determining the order point and optimizing the size of order considering the transportation costs (Teimouri, Ghiyami, 2004). Have presented some models for integrating the total logistic cost in supplying chain management (Ghazanfari, Seyed Hosseini, 2004). Have practiced to the development of a model for optimizing the total cost of logistic distribution in conditions of a producer and some distributed warehouses in supplying chain management (Ghazanfari, Seyed Hosseini, 2004). by presenting a mathematical Mosel, have practiced to lowering the transportation costs and existence in a production company which the production have been done in some stages and considering the limitation of time for producing a part till requested time to transportation (Watanabe and et.al, 1994).

The main reasons for doing this research are:

1) Reduce transportation total expected costs of raw materials to assembly lines.
2) Developing a consistent and coordinated transportation program with production plan.
3) Smoothing transportation operations throughout the assembly saloon.
4) Determination and optimum allocation of transportation operators and their lift trucks to each assembly line.
5) Make an optimum schedule for proper usage of transportation operators and their lift trucks.

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2. LITERATURE REVIEW

2.1. Supply Chain

Supplying chain consists of material stream, money and information between supplier's network, transportation, producer, distribution network and final customer (Javid, 2004).

2.2. Logistics

The keyword "logistic" has been used in the U.S.A military forces for more than one century and gradually has been accepted by the other military forces of English language countries. In the recent decades this is also developed in trade market and civil industrial. Logistic has originally come from a Greek work "logistics" and it means science of computation and skill in computerizing. Antoine Henry Jomini had the first systematic try to definition this word with low accordance and connected to the other war elements. He was a French commentator and war writer. He defined the logistic in his book 'the brief art of war" in 1838 like this: logistic is the scientism art of militaries movement. Based on his definition, the logistic apparently consists of all supporting and moving activities of militaries such as, planning (Henry Jomini, 1838).

2.3. Logistic balancing

Logistic balancing issue is an assurance for being equal of loading operation times and transferring a loading or unloading considering to production rate which is result of ideal transferring rate. Ideal transferring rate is converted to the transferring time of each part which is named such as balance index or balance time or cycle time.

Balancing the logistic operation is caused to allocating the optimum required operators in logistic process, determining the optimum transferring time, and decreasing the total expected cost of transferring operation of materials and other stuff during the building stream. Finally, this is caused to increasing the velocity of supplying parts according to the production plan and non-stopping in the production process and rapid respond to the receiving requests (Javid, 2004).

3. RESEARCH METHODOLOGY

3.1. The use of linear programming technique for minimizing the total expected cost of transportation

This objective function has two limitations which the first one is related to the Tondar 90 managers to the transportation velocity (logistic) and raising the number of transportation process to over 300 boxes per hour according to the production plan of 70 bodies per hour.

$$Min Z = 10X_1 + 6.5X_2 + 5.8X_3 + 9.17X_4 + 4.65X_5 + 6.18X_6 + 15.32X_7 + 14X_8$$

$$s.t:$$

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 = 300$$

$$26 \le X_1 \le 49$$

$$27 \le X_2 \le 50$$

$$29 \le X_3 \le 52$$

$$23 \le X_4 \le 46$$

$$37 \le X_5 \le 60$$

$$33 \le X_6 \le 56$$

$$21 \le X_7 \le 43$$

$$20 \le X_8 \le 43$$

$$X_i \ge 0 \;;\; i = 1,2,....,8$$

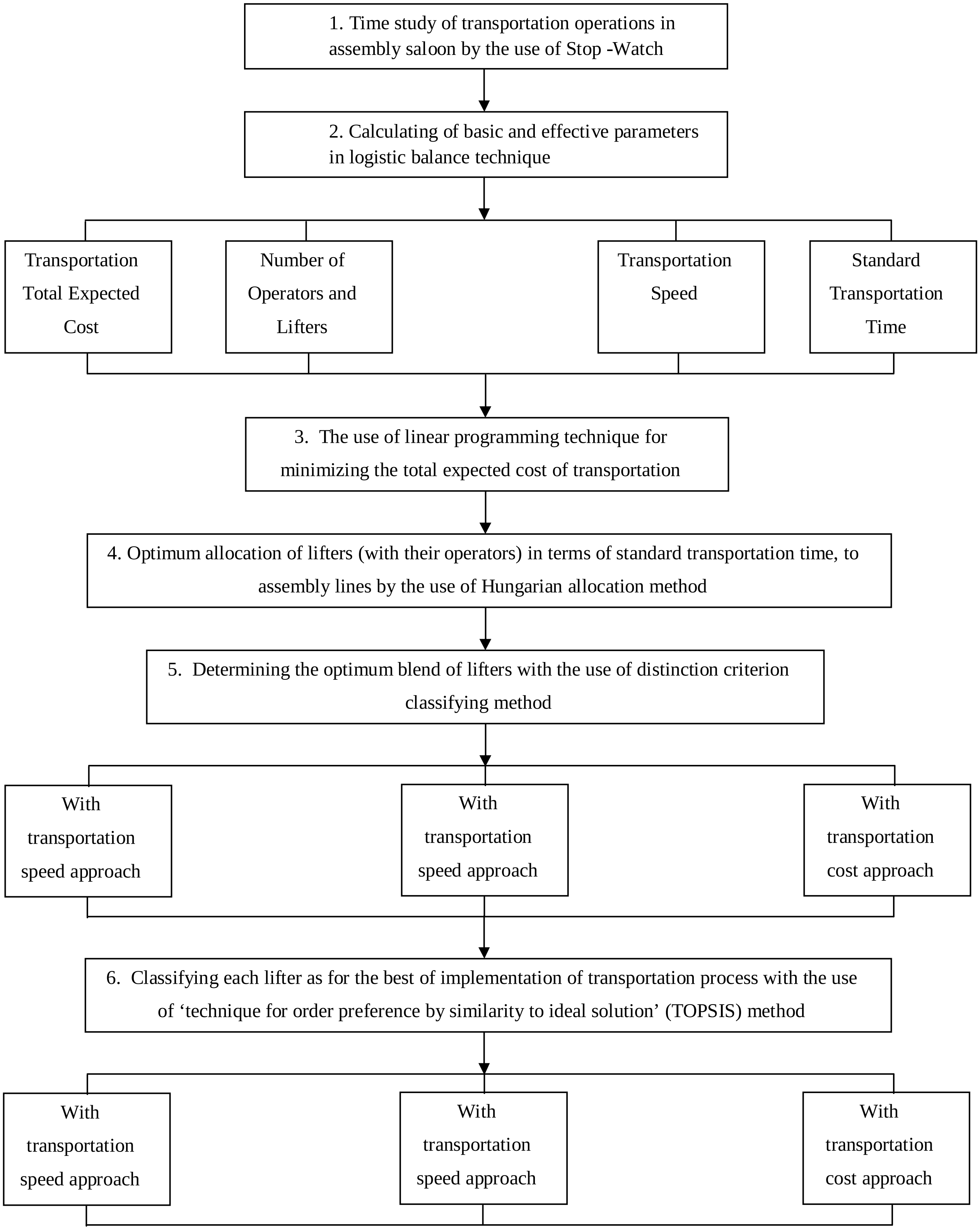
3.2. Optimum allocation of lifters to assembly lines by the use of Hungarian allocation method as fort transportation time of each lifter in every line

Table 1. Transportation process implementation time by each lifters in each line (minute)

SE6 & SE8 - A	SE4	SE2	MO3	MO1	ME5	ME3 & SE8-B	ME1	Line / Lifter
11.85	12.27	11.14	11.63	11.32	11.27	12.4	11.83	1
11.45	12.13	11.39	11.54	11.28	11.12	11.3	12.21	2
11.63	12.19	11.24	11.17	11.14	12.57	11.26	11.54	3
12.32	11.46	11.28	11.25	12.38	12.63	11.94	13.37	4
11.58	11.32	11.16	11.43	12.4	11.93	12.73	11.59	5
12.27	11.27	11.84	12.18	11.77	11.51	11.41	11.46	6
11.74	11.8	12.28	11.41	11.36	11.42	11.53	11.15	7
11.86	11.93	11.47	11.36	11.68	11.12	11.18	11.65	8

Table1 shows that transportation time of any lifters (with their operators) in each of assembly lines. The information in this table is used for optimum allocation of any lifters (with their operators).

Figure 1: Research Practical Model



3.3. Determining the optimum blend of lifters with the use of distinction criterion classifying method

Table 2: time of transportation process implementation by each lifters in each line (minute)

SE6 & SE8 - A	SE4	SE2	MO3	MO1	ME5	ME3 & SE8-B	ME1	Line / lifter
11.85	12.27	11.14	11.63	11.32	11.27	12.4	11.83	1
11.45	12.13	11.39	11.54	11.28	11.12	11.3	12.21	2
11.63	12.19	11.24	11.17	11.14	12.57	11.26	11.54	3
12.32	11.46	11.28	11.25	12.38	12.63	11.94	13.37	4
11.58	11.32	11.16	11.43	12.4	11.93	12.73	11.59	5
12.27	11.27	11.84	12.18	11.77	11.51	11.41	11.46	6

Table2 shows that transportation time of any lifters (with their operators) in each of assembly lines. Transportation time is as an efficient index doing in step of this research.

Table 3: the velocity of transportation process implementation by each lifters in each line and each transportation cycle (box per minute)

SE6 & SE8 - A	SE4	SE2	MO3	MO1	ME5	ME3 & SE8-B	ME1	**Line** / lifter
5.26	4.18	4.29	4.2	5.2	4.76	4.26	3.87	1
4.35	3.7	3.79	5.4	5.9	5.23	4.81	4.2	2
4.13	3.98	4.83	4.93	5.3	5.44	3.84	4.6	3
3.92	4.9	5.47	3.97	4.6	4.17	4.52	3.94	4
4.16	5.32	5.27	5.36	5.3	3.92	4.19	5.1	5
5.71	5.41	3.86	4.67	3.77	3.97	5.4	3.86	6
4.3	4.79	3.91	3.83	3.89	5.36	3.97	3.48	7
5.24	3.84	4.72	5.14	5.11	4.9	5.2	4.1	8

Table3 shows that transportation speed of any lifters (with their operators) in each of assembly lines. Transportation speed is as an efficient index doing in step of this research.

Table 4: the cost of transportation process implementation by each lifters in each line and each transportation cycle (Tomans per minute)

SE6 & SE8 - A	SE4	SE2	MO3	MO1	ME5	ME3 & SE8-B	ME1	Line / lifter
51.11	52.56	49.31	47.8	53.12	49.37	53.42	51.89	1
49.92	53.3	48.74	49.26	50.49	52.32	51.14	48.4	2
50.48	47.28	53.1	52.35	51.38	48.16	51.63	49.6	3
51.19	49.2	52.84	51.43	49.86	49.68	46.82	52.31	4
48.2	49.61	47.51	50.69	52.33	51.57	53.11	48.85	5
49.13	50.14	49.24	49.58	51.4	52.69	48.41	51.36	6
51.64	49.85	52.39	51.28	47.3	50.38	49.95	50.9	7
48.37	50.4	51.57	52.61	51.62	50.71	50.19	51.71	8

Table4 shows that transportation cost of any lifters (with their operators) in each of assembly lines. Transportation cost is as an efficient index doing in step of this research.

Table 5. Alternatives for the use of application mix in assembly shop during a transportation cycle

Alternative	Number of constant lifter	Number of variable lifter	Number of Extra lifter	Transportation cost	transportation time	transportation speed
A1	7	-	-	17.36	77.7	1.4
A2	7	1	-	18.18	74.93	1.45
A3	7	2	-	19	72.16	1.5
A4	7	-	1	19.84	66.6	1.6
A5	7	1	1	20.66	63.83	1.65
A6	7	-	2	22.32	55.5	1.85
A7	7	-	2	23.14	52.73	1.85

Table5 shows that three type of application mix of any lifters (with their operators) to determination the optimum blend of lifters with the use of distinction criterion classifying method.

3.4. Classifying each lifter as for the best of implementation of transportation process with the use to TOPIS method for one person (DM):

Table 6. The first decision matrix

Index / Alternative	Transportation cost	transportation time	transportation speed
A1	408.57	94.71	35.93
A2	403.61	92.42	37.38
A3	403.98	74.92	37.05
A4	403.33	96.63	35.49
A5	400.87	94.14	38.62
A6	401.95	93.71	36.66
A7	403.69	92.69	33.53
A8	407.18	93.24	38.25

Table6 shows that the first decision matrix to classifying each lifter as for the best of implementation of transportation process with the use of 'technique for order preference by similarity to ideal solution' (TOPSIS) method.

Table7. How to calculate the length of stories in order to classifying data

Transportation speed	transportation time	transportation cost	Index / Information
33.53	94.42	400.87	the minimum data
38.62	96.63	408.57	the maximum data
7	7	7	the number of stories
0.727	0.6	1.1	The length of stories

Table 7 shows that calculating the length of data stories to data classification in this step of research.

The length of stories = the number of stories (the maximum data- the minimum data)

After classifying data, the following tables will be resulted from comparing two tables of classifying and the initial table:

Table 8. Classifying indexes for converting the quality amounts to the quantity ones with the use of distance bipolar measurement method

classifying Transportation speed	classifying transportation time	classifying transportation cost	Amount based on distanced bipolar scale	Negative indexes situation	Amount based on distanced bipolar scale	Positive indexes situation
$33.53 \le V \le 34.257$	$92.42 \le t \le 93.2$	$400.87 \le c \le 401.97$	9	Very low	1	Very low
$34.257 < V \le 34.984$	$93.02 < t \le 93.62$	$401.97 < c \le 403.07$	7	low	3	low
$34.984 < V \le 35.711$	$93.62 < t \le 94.22$	$403.07 < c \le 404.17$	6	Some deal low	4	Some deal low
$35.711 < V \le 36.438$	$94.22 < t \le 94.82$	$404.17 < c \le 405.27$	5	suitable	5	suitable
$36.438 < V \le 37.165$	$94.82 < t \le 95.42$	$405.27 \le c \le 406.37$	4	Some deal high	6	Some deal high
$37.165 < V \le 37.892$	$95.52 < t \le 96.2$	$406.37 < c \le 407.47$	3	high	7	high
$37.892 < V \le 38.62$	$96.02 < t \le 96.63$	$407.47 < c \le 408.57$	1	Very high	9	Very high

Table 8 shows that data classification according to information of table7 in terms of three indexes: transportation Cost, transportation time and Transportation speed.

4. Data Analyzing

4.1. Determining and analyzing the results with the use of linear programming method for lowering the total expected cost

Table 9. Comparing the results with the use of linear programming method for minimizing the total expected cost

The sum of transportation costs in the whole assembly shop in the previous situation (Toman per hour)	$Z_1 = 310 + 211 + 228.42 + 275.35 + 629.51 + 238 + 365 + 348.27 = 2605.55$
The sum of transportation costs in the whole assembly shop in the optimum situation (Toman per hour)	$Z_2 = 260 + 273 + 301.6 + 210.91 + 346.08 + 210.12 + 321.72 + 280 = 2271.89$

Table 9 shows that comparing the results with the use of linear programming method for minimizing the total expected cost in this step of research.

4.2. Determining and analyzing the results of optimum allocating of lifters to the assembly shop with the use of Hungarian allocation method as for transportation time of each lifters in each lines

Table 10. The final of calculation of lifters allocation to each assembly line in Hungarian allocation method

SE6 &SE8-A	SE4	SE2	MO3	MO1	ME5	ME3&SE8-B	ME1	line / lifter
029	10.4	0	1.4	0.09	0.04	0.48	0.6	1
0	1.1	0.36	0.42	0.16	0	0.18	1.09	2
0.16	0.05	0.19	0.03	0	1.43	0.12	0.4	3
0.74	0.21	0.12	0	1.13	1.38	0.69	0.12	4
0	0.07	0	0.18	1.15	0.68	1.48	0.34	5
0.67	0	0.66	0.91	0.5	0.24	0.14	0.19	6
0.26	0.65	1.22	0.26	0.21	0.27	0.38	0	7
0.35	0.75	0.38	0.18	0.5	0.93	0	0.47	8

Table 10 shows that the final of calculation of lifters allocation to each assembly line in Hungarian allocation method in this step of research.

Table 11. The final results of optimum allocation of each lifter to each assembly line

The number of allocated lifter line	line
7	ME1
8	ME3&SE8-B
2	ME5
3	MO1
4	MO3
1	SE2
6	SE4
5	SE6 &SE8-A

Table 11 shows that the final results of optimum allocation of each lifter to assembly lines in this step of research.
After allocating each operator to each line, the sum of transportation process time by the whole operators for implementation of a complete cycle in the whole assembly line is equal to 89.83 minutes while this time was 116.47 minutes before the allocation.

4.3. Determining and analyzing the results of determining the optimum mix of the we of lifters with the use of distinction criterion method

Table 12. Final classifying in order to finding the best mix of lifters

	classifying
$PM_1 = (\frac{1}{17.36})^{0.26}(\frac{1}{77.7})^{0.434}(1.4)^{0.304} = 0.0797$	**7**
$PM_2 = (\frac{1}{18.18})^{0.26}(\frac{1}{74.93})^{0.434}(1.45)^{0.304} = 0.0809$	**6**
$PM_3 = (\frac{1}{19})^{0.26}(\frac{1}{72.16})^{0.434}(1.5)^{0.304} = 0.0813$	**5**
$PM_4 = (\frac{1}{19.84})^{0.26}(\frac{1}{66.6})^{0.434}(1.6)^{0.304} = 0.0841$	**4**
$PM_5 = (\frac{1}{20.66})^{0.26}(\frac{1}{63.83})^{0.434}(1.65)^{0.304} = 0.0872$	**3**
$PM_6 = (\frac{1}{22.32})^{0.26}(\frac{1}{55.5})^{0.434}(1.85)^{0.304} = 0.0941$	**2**
$PM_7 = (\frac{1}{23.14})^{0.26}(\frac{1}{52.73})^{0.434}(1.85)^{0.304} = 0.0953$	**1**

Table 12 shows that final classifying in order to finding the best mix of lifters by using of distinction criterion method.

Table 13. The table of comparison between the results of implementation of distinction criterion method

	Number of constant lifter	Number of variable lifter	Number of Extra lifter	Transportation cost	transportation time	transportation speed	Ratio of transportation speed to number of lifters
The optimum situation	7	1	2	67.102	14.23	85.1	1.85 ÷ 10 = 0.185
The previous situation	11	3	-	41.130	74.29	35.2	2.35 ÷ 14 = 0.167

Table 13 shows that the comparing the results with the use of distinction criterion method in this step of research.

4.4. Analyzing the results of classifying each lifters as for the best transportation operation performance with the use of TOPSIS method for one person (DM)

Table 14. The final results of classifying of each lifter as for the best done transportation process with the use of TOPSIS method for each person (DM)

Classifying	Alternative
2	A1
5	A2
6	A3
3	A4
4	A5
7	A6
8	A7
1	A8

Table 14 shows that the final results of classifying of each lifter as for the best done transportation process with the use of TOPSIS method in this step of research.

Table 15. Comparison between the results of classifying of each lifters as for the best done transportation process with the use of TOPSIS method for each person (DM)

	The variable lifters which is used in necessary condition	The cost of transportation (Toman per minute)	The time of transportation (minute)	The velocity of transportation (box per minute)
The optimum situation	A8	407.18	93.24	38.25
The previous situation	A4	403.33	96.63	35.49

Table 15 shows that comparing the results with the use of distinction criterion method in this step of research.

5. Conclusion and suggestion

According to the results of doing this research, the role of creating the balance in logistic system is a vital affair for every production or service organization. In fact the determining an accurate program for implementation of transportation process and feeding of assembly lines according to the changing in production plan and as for bill of materials in each workstations, is an important competitive advantage for every organization.

According to the obtained results from balancing the Tondar 90 assembly line logistic the decreasing of costs in transportation total expected in parts transportation in order to feeding of assembly line and in distribution of final products for caucusing will be observed.

Because of variety of variations, it is not possible to control the total variations that mean that some impressive variations on the result of research are out of control. So, it is suggested that the related researches in this filed should be done by all impressive variations.

As for the logistic and logistic balance and its relating to the costs is a new issue in Iranian organizations, so in considering of its indexes and in organizations and filed study, this research has been faced with the previous researches limitations. Also it is suggested that research in this field should be done by impressive various indexes in logistic and different organizations.

As for the difference between applied parts in the final product and various solid of them and various size in batches of each parts and also the various size of boxes, only the main applied parts in the final product have been considered and analyzed. So, it is suggested that the related researches should be done with the regards of all parts as for various solid and size and their importance in the final product.

As for various transportation machines, in this study, just the main tools for transportation, which is called lifter, have been analyzed and considered. So, we suggest that the related research in this field, with regards of the total transportation tools or machined such as trailers, tows and AGVS (lifter without drivers), should be done.

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2. Asgari, Nasrin and Aghdasi, Mohammad (2004) also was choosing as case study with the purpose of decreasing the transportation costs in Iran Khodro Company.

3. Teimouri, Ebrahim and Ghiyami Yousef (2004) also have presented a model for determining the order point and optimizing the size of order considering the transportation costs.

4. Ghazanfari, Hossein and seyed Hosseini seyed Mohammad (2004) have presented some models for integrating the total logistic cost in supplying chain management.

5. Ghazanfari, Hossein and Hosseini, seyed Mohammad (2004), have practiced to the development of a model for optimizing the total cost of logistic distribution in conditions of a producer and some distributed warehouses in supplying chain management.

6. Watanabe and et.al (1994) by presenting a mathematical Mosel, have practiced to lowering the transportation costs and existence in a production company which the production have been done in some stages and considering the limitation of time for producing a part till requested time to transportation.

7. Nozick and turnquist (2000), as for theory of integrating process, transportation cost and facilities cost and existence, have presented a mathematical model and for considering the performance of the presented model, they have opted a car making factory as a case study.

8**.** Dasci and cetter (2001) have presented a model for supplying-distribution system based on application of continuous function in order to presenting the distribution cost and customer request.

9. Nishazaki (2001) and et.al also modeled this matter as a phase modeling. In this study the purpose function is for decreasing the cost of transportation, travel time and the number of vehicle.

10. Bamol and winod (1993), have done the first prompts for determining the transportation vehicle in an alone product more which could be a model of decreasing the existence and transportation cost.

11. Constable and reyolds(1975) have developed a theoretical model for developing the costs of transportation and return of order. These models determine the reclaim of existence point, amount of order and choose a transportation vehicle which lowers the existence and transportation cost, continuously.