Erasmus University Rotterdam

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# Analysis of Logistics integration effectiveness

# Based on Samsung model

By

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# Acknowledgements

Sometimes I can't believe how quickly the time has gone by. The days in MEL have gone by and I am now in the office as I used to do like the time I studied in the Netherlands never happened. When I was in Samsung Electronics, I was exhausted by overwhelming amount of work every day and night and I was running toward something pointless. Maybe I was trying to look for a new way out.

While I was wandering off course, one verse from Frost's poetry inspired me. "Two roads diverged in a wood, and I took the one less travelled by, and that has made all the difference." The decision to study in MEL was not an easy but it led me to all the difference.

My school days in MEL taught me how to view a matter from a different standpoint and how I was a man of narrow views. And now it helps me to manage my employees and department as not only a manager but also an expert in SCM industry. Therefore I would like to thank you Mr. Frost who inspired me the way to go.

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Yong-hyeok (Brian) Jang

# Abstract

In this paper we give an overview of Samsung's Logistics Integration over the last five years. Furthermore this paper shows on what grounds the Samsung's logistics operation integrated and what this means for the logistics flows of Samsung Electronics and how it can be explained and analyzed based on academic researches and literatures.

Even though Samsung's logistics integration mostly has shown very positive results, there is still some room to improve more and the Performance Index comparison between before and after the logistics integration will guide us what has been improved by using statistical methods.

Finally this paper will give you an idea with a detail examples actually adjusted in Samsung's daily logistics operation which lead to a successful logistics integration Furthermore it would be also applicable as a possible solution which may improve alike Performance Index in other logistics companies so that their logistics integration effectiveness can be maximized and optimized while it keep their current advantages of logistics integration.

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# List of abbreviation

| | |
|---|---|
| ***IT system*** | Information technology system |
| ***W/H*** | Warehouse |
| ***3PL*** | third party logistic service for instance DHL |
| ***Shipper*** | Consignor, client company for instance Samsung |
| ***Customer*** | consignee , customer of client company for instance Media market |
| ***OTD*** | On Time Outbound delivery performance index for the timely delivery |
| ***GR*** | Good receipts in warehouse |
| ***GI*** | Good issued from warehouse |
| ***GVC*** | Gross Volume Calculation to expect a number of pallet loaded on a truck |
| ***TMS*** | transport management system such as L2 (logic logistics) |
| ***WMS*** | warehouse management system such as Manhattan |
| ***IOD*** | Information on delivery usually input by carriers |
| ***SCM*** | Supply Chain Management |
| ***EUR*** | Euro Pallet |
| ***EDC*** | Europe Distribution Center |
| ***HSF*** | High Security Fleet |

# Chapter 1 Introduction

Chapter 1 will state the trend of Supply Chain industry briefly and research objectives and research question and methodologies used to analyze the collected data so that the readers could easily understand what the main aim of the thesis. The structure of the research will be describe in the research question and objective below and the answers for the research questions will be followed in the next accordingly.

## *1.1 Introduction*

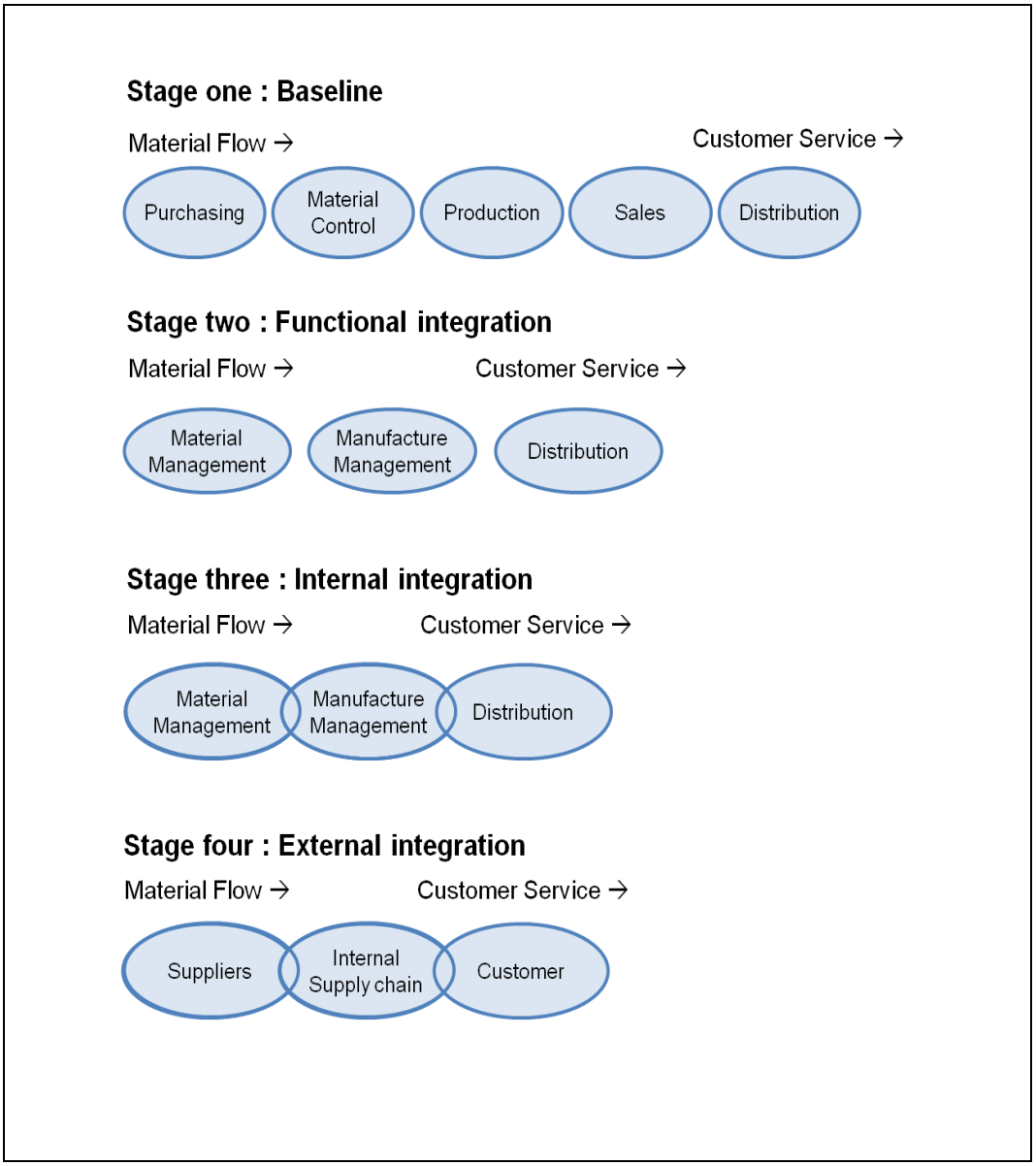
Today it is common and necessary for manufacturing companies to have a full control over the SCM (Supply Chain Management) from manufacturing to distribution to the customer no matter what kinds of products they handle.

"Traditionally, the flow of material has been considered only at an operational level, at best driven by efficiency improvement and cost reduction, at worst abandoned to be battered by the demands of a rapidly changing competitive environment. For many companies the need to react to market changes is paramount; the role of the supply chain is crucial. **No longer can the potential of integrating the supply chain be ignored**" (Stevens, 2007).

According to Stevens, there are 4 different development stages of Supply chain such as baseline stage, functional integration, internal integration and finally external integration and the ultimate objective supply chain optimization is logistics integration. See figure 1.1. Stage 1 represents the base line case. The supply chain is a function of fragmented operations within the individual company and is characterized by staged inventories, independent and incompatible control systems and procedures, and functional segregation (Stevens, 2007). In this stage, the planning term of company is rather short so most of counter plan to crisis is very much ad-hoc base.

In the base line stage, as it is not possible to establish long term plan due to lack of information and corporation among involved parties in the supply chain, the supply chain operation itself is very much inefficient. Additionally it puts in jeopardy the overall effectiveness of the supply chain as well as increasing the company's

vulnerability to the effects of changes in supply and demand patterns (Stevens, 2007).




**(Figure 1.1)** Trend of Supply Chain Development

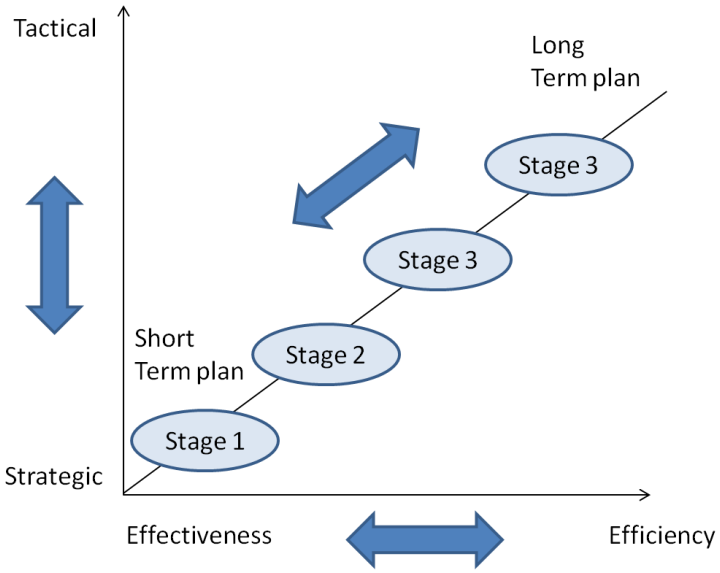
(**Source)** Stevens, "Achieving an Integrated Supply Chain", 2007

In addition, In the Stage 2, the supply chain begins to more focus internal integration, characterized by an emphasis on cost reduction rather than performance improvement, buffer inventory, initial evaluations of internal trade-offs, and reactive customer service and in the Stage 3, it almost reaches toward internal corporate integration and characterized by full visibility of purchasing through

distribution, medium-term planning, tactical rather than strategic focus, emphasis on efficiency, extended use of electronics support for linkages, and a continued reactive approach to customers. (Stevens, 2007)

Lastly in the Stage 4, the supply chain integration is achieved by expanding logistics integration span outside the company in order to hold close customers and suppliers. As it can be seen, as the phase is developed, the supply chains will have clearer system visibility from distribution through to purchasing and the term of planning is be longer than the previous stage. Furthermore the focus of the SCM (Supply Chain Management) is toward from tactical to strategic issues and strategies for SCM (Supply Chain Management) innovation will be more efficient toward than effects for short term. See Figure 1.2.

Electronic data interchange through EDI will be more widespread to support the customer link and facilitate a faster response and it will be more “reacting” to customer demand rather than "managing" the customer (Stevens, 2007). The enhanced cooperation and electronic data interchange through EDI by logistics integration will allow full management of all level of supply chain and it will lead to high service quality by delivering shipments on time which will also improve customer satisfaction. Moreover efficiency and tactical driven long term plan will make massive logistics cost saving possible.




**(Figure 1.2)** Characteristics of each stage (Stevens, 2007)

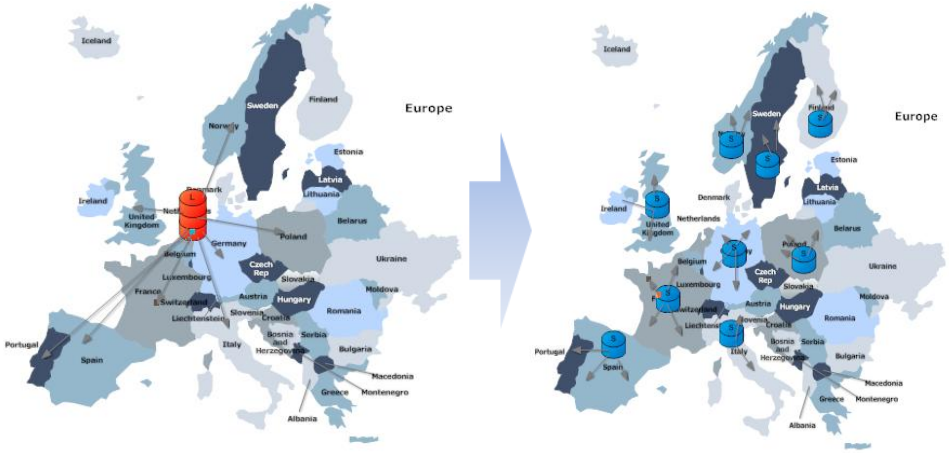
## *1.2 Motivation*

"When Samsung decided to integrate the several western European sales subsidiaries in 2008 (Figure1.1) into a logistics distribution centre (Figure1.2), we expected certain positive effectiveness.

The first positive factor was to decrease the bad aging stock in each sales subsidiary in Europe by integrating the each W/H into a distribution centre. We assumed to build a big virtual W/H so that each sales subsidiary could start their daily operation via the virtual W/H like their own W/H.

Although it is not their own W/H (warehouse) but shared with other sales subsidiaries, they are able to check the overall actual stock status for a specific model in the W/H in real time.

As a result, even if a specific model in one country is a slow moving product (Possibility to become a bad aging stock), it might be a fast moving product in other market. In addition, the sales subsidiaries in that market are able to see all the stock's aging status and availability systematically as they have a virtual W/H system via the integrated logistics center.




(Figure 1.3) Physical W/H operation (Figure 1.4) Integrated logistics operation

(Source) Kim "Strategy of Internalizing Main Success Factors from 3PL Providers" 2009

Secondly, we also expected logistical performance improvement such as On Time Good issue (OTG), On Time Delivery (OTD) and Stock availability rate. As we have a decreased aging stock in the W/H (Warehouse), we also expect an increase stock availability via move allocation at the same time and as the logistics operation

is being managed by logistics specialized company so called 4PL, the logistical performance can be improved.

Lastly, as sales subsidiaries focus on only their own roles such as marketing and demand forecast not the logistics operation, the accuracy of demand forecast on the market could be improved. It is very important part to avoid the unnecessary over stock allocation situation in advance.

In this study, I would like to show if the logistics integration has actually improved the daily operation by analyzing the historical performance index data for the last 4 years (2007-2010) by using the statically method.

Finally this paper will show a detail examples actually adjusted in Samsung's logistics operation which lead to a successful logistics integration and will also suggest a possible solution which could improve the performance index more so that the logistics integration effectiveness can be maximized and optimized while it keep its current advantages of logistics integration." (Jang, 2010)

### *1.3 Research question and objective*

As mentioned in the problem statement, the logistics integration in Samsung was a big issue in 2007 because Samsung used to distribute most of goods from factories to the subsidiaries' warehouse in each European country and never delivered to customers directly by using the integrated logistics concept.

It's been passed more than 3 years and now we would like to show how the Samsung EDC's logistics integration model was built and how well it affects to each logistical performance evaluation categories in positive and negative. Therefore, the main research question is:

**"Does the logistics integration have a positive impact on logistical performance in the Samsung EDC?"**

To find the answers for the question, we will first need to investigate what logistical performance index is linked to logistics integration by reviewing academic literatures. After the study, two groups of logistical performance index which are from before

and after the logistics integration in Samsung EDC will be compared in order to investigate if there is either positive or negative effectiveness by the integration. As can be seen in figure 1.3, the respondents experienced the logistics integration in their firms think that how successful their firms were by the logistics integration can be gauged by six areas as below and each area is answered by seven-point scale. (1 = not at all successful; 7 = extremely successful)

| | Performance improvements | Mean | SD |
|---|---|---|---|
| Performance | Improved customer service (X1) | 5.41 | 1.26 |
| | Quality improvements (X2) | 5.14 | 1.30 |
| | Productivity improvements (X3) | 5.09 | 1.34 |
| | Reduced costs (X4) | 5.06 | 1.34 |
| | Improved strategic focus (X5) | 5.00 | 1.44 |
| | Cycle time reductions (X6) | 4.89 | 1.58 |

**Figure 1.3** The linkage between integration and logistical performance
**Source**: Daugherty, Ellinger, Gustin, “Integrated logistics” (2005)

Once we can make up the hypothesis that there was a positive effectiveness, we will need to explain how this performance was improved. To measure the effectiveness, we have established the category of the logistics performance to be checked which are currently in use not only in Samsung EDC but also in the entire Samsung Group as below. (See Table 1.1)

| Questions | Index concepts |
|---|---|
| Q1 | Bad Aging Stock Rate |
| Q2 | Stock Availability rate |
| Q3 | On Time Good Issue Rate |
| Q4 | On Time Delivery Rate |
| Q5 | On Time IOD Rate |
| Q6 | Logistics Cost reduction |
| Q7 | Improvement of consolidation |
| Q8 | Demand forecast accuracy |
| Q9 | Advance Delivery Visibility |

**Table 1.1** Key factors expected from the logistics integration

Then we have mapped the nine hypothesis questions with six performance indexes expected to be improved from logistics integration as Figure 1.5. As there is several logistical performance indexes belong to more than one “X” category, I have mapped them accordingly. For example, Q3 does exist not only in X3 but also X4 as it’s about cost reduction and Productivity improvements for both.

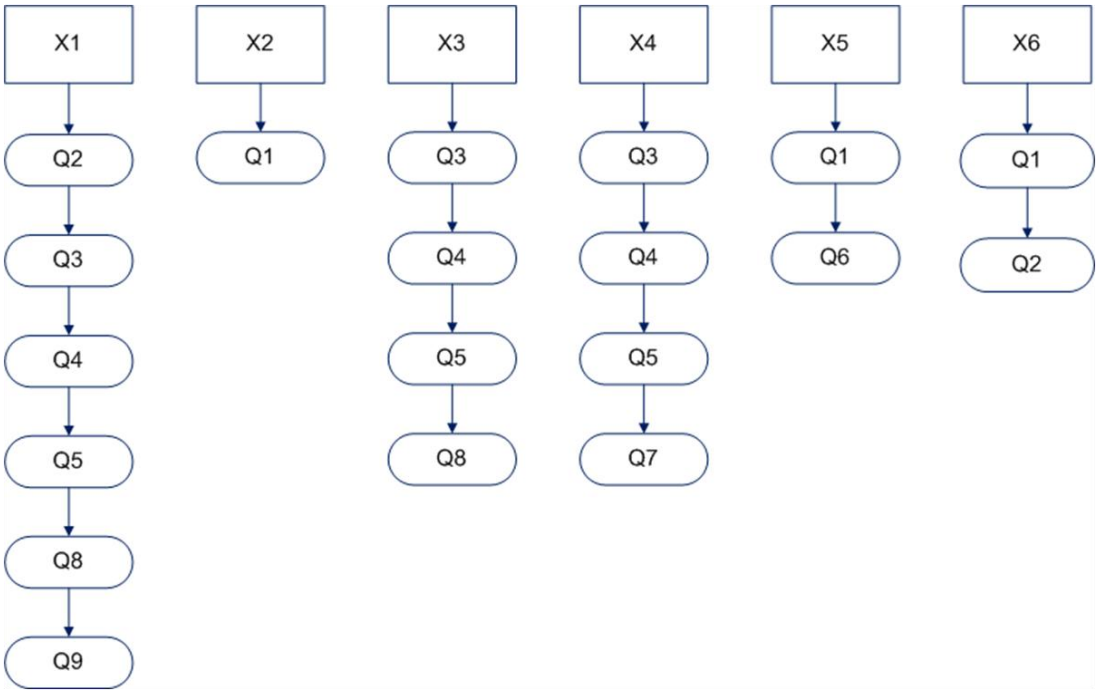



**Figure 1.5** The mapping of diagram for hypothesis test.

Meanwhile, the object of this study is to answer for the research question and develop further discipline in order to contribute practically for management group, who is in charge of supervising and evaluating the performance in logistics firm, to be able to utilize by providing them a correct methodology to evaluate the effectiveness of their logistics integration after all.

### *1.4 Methodology*

This research study will introduce the linkage between logistics integration and logistical performance academically and practically based on the Samsung logistics integration model. Firstly the definition of logistics integration and logistical performance will be reviewed. The related logistical performance index, which are mentioned not only as an example of the performance improvement in the academic literatures but also currently in use at the Samsung EDC, will be suggested as an

example of performance improvement to prove the linkage of the relationship between logistics integration and logistical performance.

After the academic reviewing derived from literatures, the conceptual method will be performed to interpret the correlation between two independent variables by executing these 2 investigation groups (Before the logistics integration (A) and after the after logistics integration (B)). We will compute the changes by data mining in this company which has been collected for the last 4 years and then we will compare the gap between the concept reviewed in the literatures and the data additionally.

The hypothesis will be also established if those indexed changes are recognized as significant or not by comparing the calculated t Stat from Excel against t Critical One tail value which is 5% of significance level. If t Stat is greater than t Critical one tail value then we reject null hypothesis (H0) in favour of alternative hypothesis (H1)

The scope of the test executed is very limited and only customer electronics industry might be applied as the case study will focus on the practical example in the company. Nevertheless the attempt itself would be carrying great weight as this sort of case study has hardly performed due to lack of data availability.

So this should be considered as a meaningful attempt as it would present some insights for a company which would like to innovate their existing logistics network and has many questions on the subject of performance improvement out of logistics integration.

### *1.5 Research structure*

In general research is prepared to perform the statistic tests from initiating the research questions to end with answers to analyze how the logistics integration based on Samsung model affects to the overall logistical performance. Each chapter is described as following

**Chapter 1**: This contains trend of Supply Chain Development and its characteristics of each development stage briefly. Here it also explains research objectives and question with methodologies which used to analyze the collected data to so that the

readers could easily understand what the main aim of the thesis.

**Chapter 2**: This chapter provides the insights for good research design and what this research can contribute to the scientific research community that is different when we compared to other research studies. Mainly we will focus on studying the linkage between integration and logistical performance which has been already studied by others and how we adjust this to our current study.

**Chapter 3**: The aim of this chapter is to explain how the survey data and data mining jobs have been performed and how the collected data are analyzed. This chapter plays as a bridge role in order to give a brief idea how the next chapters will support each other so that the conclusion to be made be more significantly supported.

**Chapter 4**: It is mainly focusing to analyze the survey questions regarding the linkage between the logistics integration and the logistical Performance Index and the survey result will be analyzed by performing t test to prove whether this survey results are significant or not.

**Chapter 5**: It states how the logistics operation has been improved by the logistics integration in Samsung EDC by analyzing the data collected from Samsung GLP system with practical examples which have adjusted to improve and maximize the performance of daily logistics operation in the integrated logistics environment at the Samsung EDC. The each analyzed data in this chapter will be compared with the survey results in order to verify if the result of the analyzed data is significant enough.

**Chapter 6:** It states a summary of the analysis results with a brief conclusion regarding the research question. Furthermore it also states the possible research topics which can be discussed more by others.

# Chapter 2 Literature Review

## 2.1 Introduction

A literature review provides insights for good research design and what this research can contribute to the scientific research community that is different when compared to other research studies. In this chapter, three fields of literature are reviewed such as the linkage between integration and logistical performance

## 2.2 Linkage between integration and logistical performance

When we talk about logistics integration, it's generally categorized into 2 parts such as internal integration and external integration. The integration within the firm's boundaries is defined as the internal integration. For example, the internal integration aim to eliminate the traditional fictional silo [1]approaches where each business area often works quite independently from the other and emphasizes better coordination among functional area. In addition, the internal integration is characterized by: (Stevens, 2007)

- Full systems visibility from distribution through to purchasing;
- Medium-term planning;
- The focus on tactical rather than strategic issues;
- An emphasis on efficiency rather than effectiveness
  - ensuring what is done is done well, rather than ensuring that the right thing is done;
- Extensive use of electronic data interchange to support the customer link and facilitate a faster response,
- Reacting to customer demand rather than "managing" the customer.

"External integration, on the other hands, has to be studied along the supply chain: It is the integration of the logistics activities across forms boundaries. It follows that external integration refers to the coordination and collaboration with other supply chain members." (Gimenez and Ventura, 2005)

[1] Individual departments or functions are strong and efficient, but the communication or connection between them is weak. (Lawrence F, 1991)

So it is not until external integration that full supply chain integration is achieved by extending the scope of integration outside the company to embrace suppliers and customers. (Stevens, 2007)

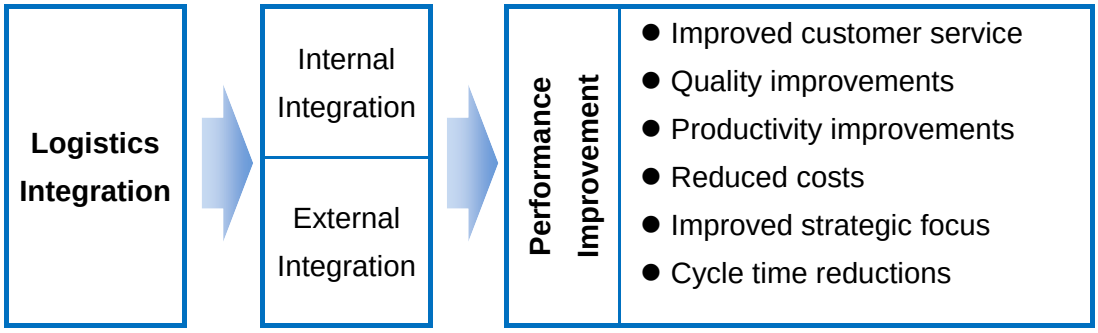



**Figure 2.1** The linkage between integration and logistical performance
**Source**: Daugherty, Ellinger, Gustin, "Integrated logistics" (2005)

As it's already been studied in the Research question and objective chapter, the logistical performance is measured within 6 areas such as improved customer service, Quality improvements, Productivity improvements, reduced costs, improved strategic focus, Cycle time reductions and "Firms which have implemented integrated logistics reported significantly greater success in achieving performance improvements in all six areas examined." (Daugherty, Ellinger and Gustin, 2005)

Stank, Keller and Closs subdivided the above two types of integration and six logistical performance again into five types of integrations and thirteen key performance index in their research. (See Figure 2.2) In their research the results associated with the relationships between the logistics competencies and performance show that improved supply chain logistics integration relates to better operating performance. (Stank, Keller and Closs, 2005)

As can be seen in the figure 2.2, the five different areas are internal integration, material/Service supplier integration, technology and planning Integration, measurement Integration, relationship Integration.

### *2.2.1. Internal Integration*

Internal integration is the ability of linking internally performed work into a flawless process to hold up customer requirements (Stank, Keller and Closs, 2005) and it covers five categories as following.

- Cross-Functional Unification
- Standardization
- Simplification
- Compliance
- Structural Adaptation

| Logistics Integration | | | | |
|---|---|---|---|---|
| Internal Integration | Material/Service Supplier Integration | Technology and Planning Integration | Measurement Integration | Relationship Integration |

| Performance Improvement | |
|---|---|
| ● ASN (Advanced Shipping Notification)[2] | ● Information support |
| ● Customer Satisfaction | ● Low logistics cost |
| ● Delivery dependability | ● Order fill capacity |
| ● Delivery speed | ● Order flexibility |
| ● Delivery time flexibility | ● Product flexibility |
| ● Inventory turns | ● Responsiveness to key customers |
| | ● Return on assets (ROA)[3] |

**Figure 2.2** Logistical Performance Matrixes

**Source**: Stank, Keller, Closs, "Performance Benefits of Supply Chain Logistical Integration" (2005)

### *2.2.2. Material/Service Supplier Integration*

It is the competency linking externally performed work into a seamless congruency with internal work processes. (Stank, Keller and Closs, 2005) and it covers four categories as following.

- Strategic Alignment
- Operational Fusion

[2] Advanced Shipping Notification : The ability to notify customers in advance of delivery when products will arrive
[3] Return On Assets: The ratio of income before interest expense divided by average total assets.

- Financial Linkage
- Supplier Management

### *2.2.3. Technology and Planning Integration*

Technology and Planning Integration is the competency of maintaining information systems capable of supporting a wide variety of operational configurations needed to serve diverse market segments. (Stank, Keller and Closs, 2005) and it covers four categories as next.

- Information Management
- Internal
- Connectivity
- Collaborative Forecasting and Planning

### *2.2.4. Measurement Integration*

It is about the development and maintenance of measurement systems that facilitate segmental strategies and processes. (Stank, Keller and Closs, 2005) and it covers four categories as below.

- Functional Assessment
- Activity Based and Total Cost Methodology
- Comprehensive Metrics
- Financial Impact

### *2.2.5. Relationship Integration*

Lastly relationship integration is the competency to develop and maintain a shared mental framework with customers and suppliers regarding inter-enterprise dependency and principles of collaboration. (Stank, Keller and Closs, 2005) and it covers four categories as next.

- Role Specificity
- Guidelines
- Information Sharing
- Gain/Risk Sharing

## 2.3 Conclusions

This literature review has been focused on the specific case, Samsung EDC, in order to confront hypothesis question in the coming chapters next. Also the literature review was mainly done with the intention of connecting the general academic knowledge to the specific Samsung EDC case so that we can also apply this case study to general industry cases.

During the literature review, general benefits expected from logistics integration have been interpreted as 6 dependent variables (see figure 1.3) and the 9 logistical performance index in use in Samsung EDC (see table 1.1) has been allocated into those 6 variables so that we can examine 9 dependent variables by the analysis of the results from surveys and data mining with corresponding examples.

# Chapter 3 Data collection

## 3.1 Introduction

In this chapter, we give explanation the purpose of the questionnaire and how the data has been collected. Furthermore we give details how the question and answers are selected in the survey.

## 3.2 Designing the data collections

In order to study this research objectively, the survey method has been chosen. Because as there are several parties involved in the daily operation in the scope of the survey, this method allows us to keep the distance objectively out of the study. Likert-type scale method using a seven-point Likert item has been adapted. Briefly speaking, Likert-type scale method is a common ratings format for surveys. Respondents rank quality from high to low or best to worst by using either five or seven levels. These scales range indicates how much respondents agree or disagree, approve or disapprove with questionnaire.

Although 5 point scales that most people are familiar with today, this time 7 point scales are used in order to differentiate the survey results more clearly from respondents. Likert Scale Response Categories which have been defined for the survey are as below. The survey questions which have been asked by using 7 point scales are in the appendix.

| Scale | Categories |
|---|---|
| **-3** | Strongly negative influence |
| **-2** | Considerable negative influence |
| **-1** | Slightly negative influence |
| **0** | No influence at all |
| **1** | Slightly positive influence |
| **2** | Considerable positive influence |
| **3** | Strongly positive influence |

**Table 3.1** Likert Scale Response Categories

**Source**: Allen, Seaman, “Likert Scales and Data Analyses” (2007)

Additionally, the survey population is categorized into 5 groups as below. Generally speaking, the integrated warehouse in the Samsung EDC is consisted of 2 parties such as Samsung (EDC) itself and DHL freight which is a service provider. Although each of them belongs to two different parties, they corporate in the same place so called control tower in order to increase work efficiency.

Although the ratio of each parties in the control tower started from half to half in 2007, now it's been changed to 70% (Samsung) to 30%(Supplier) as Samsung took over majority of the work which used to belong to suppliers. However the suppliers still play an important role in the daily operation of Samsung EDC so the both parties were also in the scope of the survey.

Besides sales subsidiaries which cooperate with the other parties so called an order desk for sales and purchasing order processing were also included in the scope of the survey as a stake holder of business. Lastly warehouse operators named DSC which secures not only Samsung's but also their own properties such as equipments and warehouse itself are also included in the scope of the survey.

- Supplier (Carriers)
- SAMSUNG (EDC)
- DSC (Warehouse operator)
- SAMSUNG (Sales Subsidiary)
- Customers (consignee)

As the answers for the survey questions may be different based upon the group of population and job position and working period, these screening questions have been asked to each respondent.

### 3.3 Executing the data collections & analysis

The survey has been carried out during the period between 1st of Aug and 5th of Aug and the survey questionnaire was asked by emailing the link of the web based survey tool (http://ko.surveymonkey.net) in order to perform the survey more efficiently. Before the survey questions were distributed, I sent the two emails to our department employees in order to check if all functionalities in the survey website

work correctly. After that the questions were sent to all respondents and finally, the survey results have been analyzed by performing Excel 2007 data analysis plus add-on.

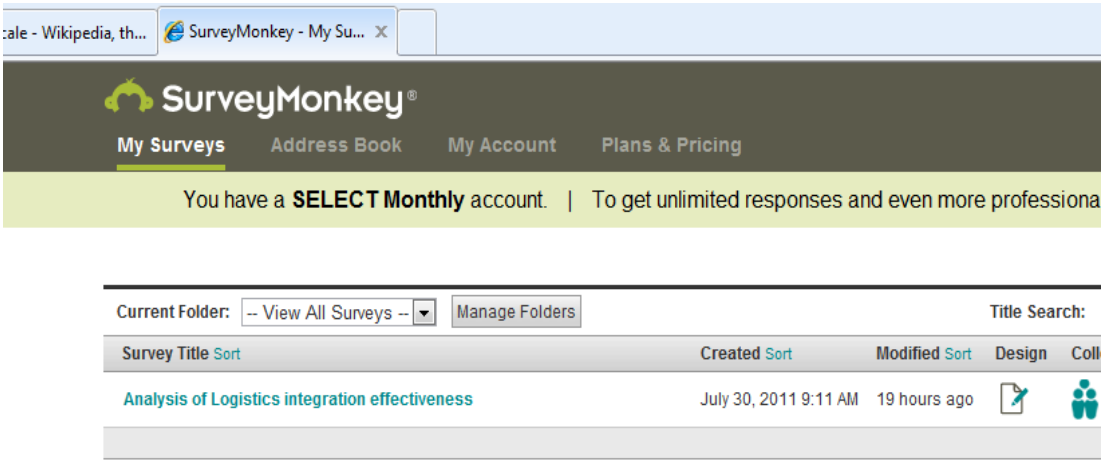



**Figure3.1** survey tool (Survey Monkey)

In addition to the survey, the historical data collected since 2007 from Samsung ERP (www.samsungglpeu.com) has been extracted in order to compare the data mining results with the survey results at the same time. As the purpose of this study is to investigate the effectiveness of the logistics integration, the test group has been divided into two. Test group A is from before the logistics integration and test group B is from after the integration. And Excel 2007 data analysis plus add-on also has been used to compare two groups statically.

In total 150 surveys were sent by e-mail including the link directly connected to the survey website and 35 surveys were returned. The response rate for the survey was about 23.3%. The reason why this response ratio is so low is partially it is summer holiday season and besides it was just right after the month end which is the most hectic period in most companies due to settlement of accounts.

As can be seen, the survey questionnaire covers all the questions and the main data extracted from the ERP system will cover the question from 1 to 8 and the rest of them will be covered with the applicable examples which are already in use in the Samsung EDC's daily operation. The availabilities of this comparison are remarked in table 3.2

| Questions | Index concepts | Covered by | | |
|---|---|---|---|---|
| | | Survey | Data Mining | Example |
| Q1 | **Bad Aging Stock Rate** | ■ | ■ | |
| Q2 | **Stock Availability rate** | ■ | ■ | |
| Q3 | **On Time Good Issue Rate** | ■ | ■ | ■ |
| Q4 | **On Time Delivery Rate** | ■ | ■ | ■ |
| Q5 | **On Time IOD Rate** | ■ | ■ | |
| Q6 | **Logistics Cost reduction** | ■ | ■ | |
| Q7 | **Improvement of consolidation** | ■ | ■ | ■ |
| Q8 | **Demand forecast accuracy** | ■ | ■ | |
| Q9 | **Advance Delivery Visibility** | ■ | | ■ |

**Table 3.2** Analysis method table

# Chapter 4 Survey Result

## 4.1 Introduction

This chapter covers four screening questions which help us to understand the respondent's career background such as company, job category and length of serve. In addition to the screening questions, the nine main questions about logistical performance index helps us how the people experienced the logistics integration in Samsung EDC actually think the effectiveness of the integration. And finally we link the analysis of the data mining results with the survey results to verify our research question.

## 4.2 Survey results for the screening questions

Before we start analyzing the main questions, the four screening question results are reviewed as it is essential to be aware of the respondents' carrier background in order to interpret the main questions properly without distorting the facts.

### *4.2.1 Question1. What is your company category?*

The aim of the question is to verify how the respondents' company category is consisted of. As the main research questions are mostly related with logistical performance indexes which are directly measured by Samsung EDC and supplier (Carriers), it will give us more sense that the majority groups of the survey are from Samsung EDC and carriers as the both parties' total ratio of the survey is 82.8%.

| What is your company category? | | |
|---|---|---|
| Answer Options | **Response Percent** | **Response Count** |
| **Supplier(Carriers)** | 11.4% | 4 |
| **SAMSUNG(EEDC)** | 71.4% | 25 |
| **DSC(Warehouse operator)** | 5.7% | 2 |
| **SAMSUNG(Sales Subsidiary)** | 5.7% | 2 |
| **Customers(consignee)** | 5.7% | 2 |
| | *answered question* | **35** |
| | *skipped question* | **0** |

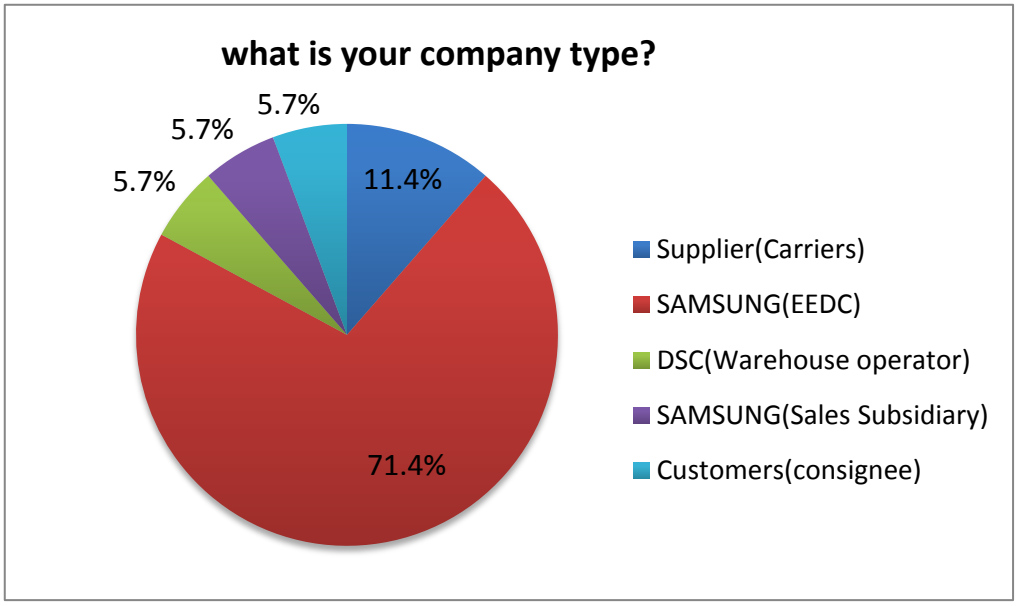



**Table 4.1** Result for the screening question 1

In addition to above, the logistical performance indexes are measured not only by Samsung EDC and Sales subsidiaries but also by Carriers and DCS. As Sales subsidiaries are also a part of Samsung group so called global ERP group so the data what they refer to as a performance index is actually the same as what Samsung EDC refers to. On the other hand, In case of Carriers and DSC group, as they are not part of Samsung global ERP group, they are not able to access the Global ERP system.

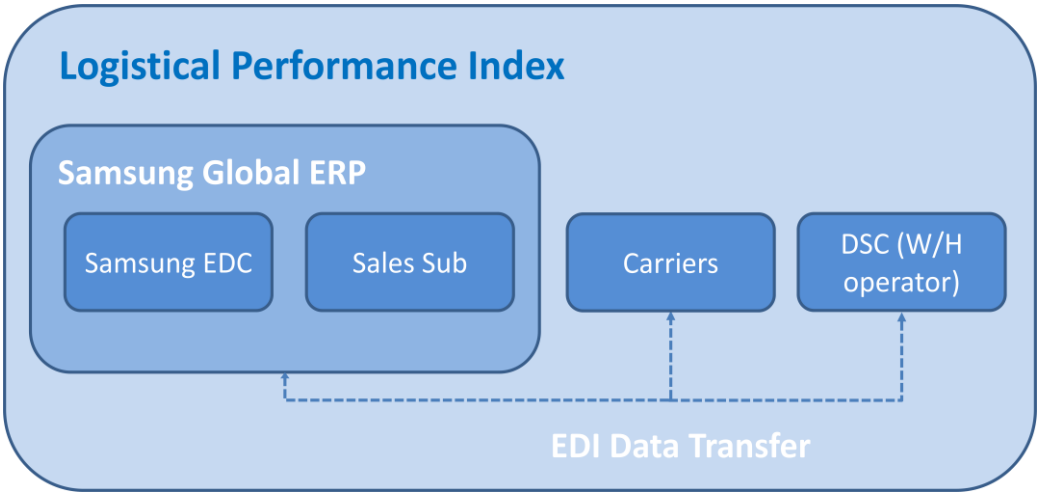



**Figure 4.1** Data interface between four parties

However as they are connected with EDI, eventually four different parties shares the same necessary data to calculate the logistical performance index. In case of

customers, they only can judge the change based on what they feel on a field as there is no direct EDI connection with Samsung system. Please see figure 4.1.

### *4.2.2 Question2. What is your job category?*

Table 4.2 shows that the majority of the respondents are from Management and operation level which are in total 74.3%. Firstly in case of management level, their biggest concern is to improvement the performance and also as they regularly check the performance index, they know a lot more than anyone how the logistics integration influenced to the performance itself.

| What is your job category? | | |
|---|---|---|
| Answer Options | **Response Percent** | **Response Count** |
| **Operations** | 40.0% | 14 |
| **Finance** | 11.4% | 4 |
| **IT(Innovation)** | 11.4% | 4 |
| **Planning(Strategy)** | 2.9% | 1 |
| **Management** | 34.3% | 12 |
| | *answered question* | **35** |
| | *skipped question* | **0** |

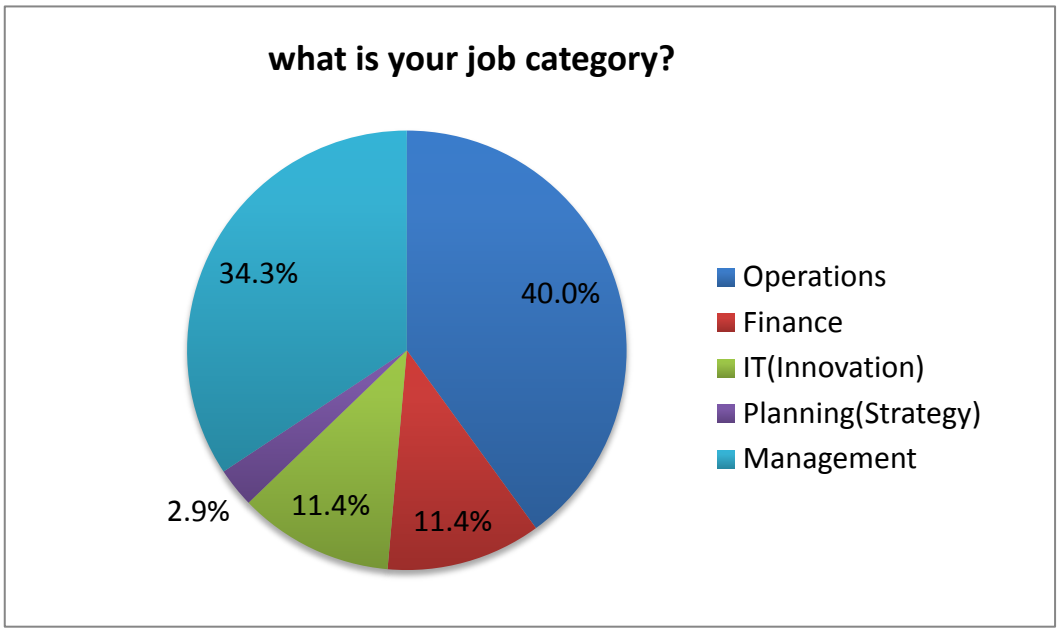



**Table 4.2** Result for the screening question 2

Furthermore, as people from the operation level sense the physical change first on a field so their responses also give very practical perception on the questions. As some of the survey questions such as cost reduction and visibility of shipments are directly connected with finance and IT level, they are also included in the survey.

### *4.2.3 Question3. How long have you been working with EDC?*

The aim of the question is to have respondent's opinions about the relationship between the logistics integration and the logistical performance improvement in Samsung EDC. As the integration was done 4 years ago, the majority of the respondents having over 4 year work experience, 66.7% with Samsung EDC makes the results of the survey significant.

.

| How long have you been working with EDC? | | |
|---|---|---|
| Answer Options | **Response Percent** | **Response Count** |
| **below 6 months** | 2.9% | 1 |
| **below 1 year** | 0.0% | 0 |
| **below 2 years** | 5.7% | 2 |
| **below 3 years** | 25.7% | 9 |
| **over 4 years** | 65.7% | 23 |
| | *answered question* | **35** |
| | *skipped question* | **0** |

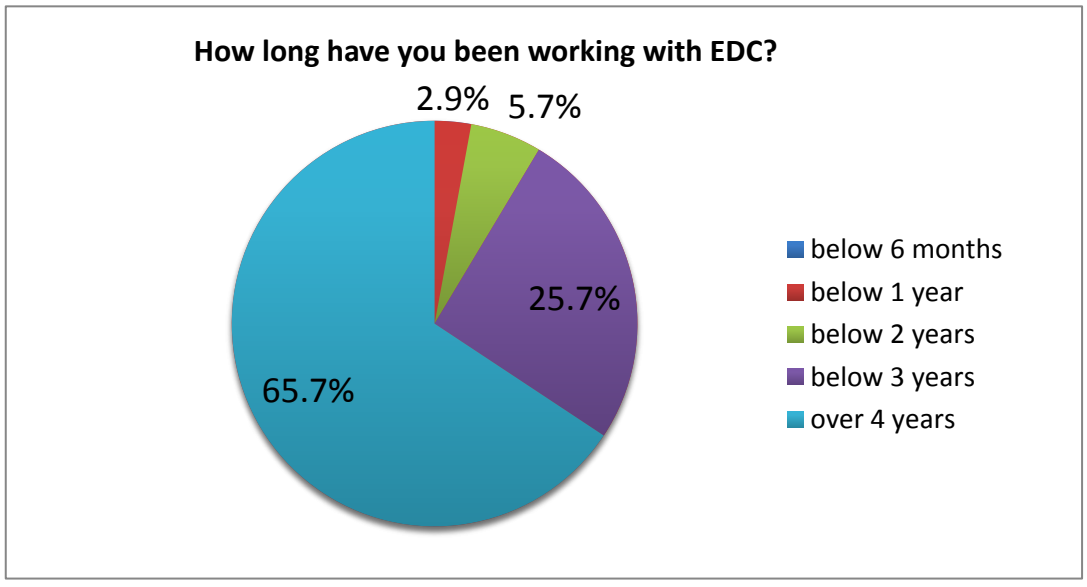



**Table 4.3** Result for the screening question 3

### *4.2.4 Question4. The most significant factor affecting logistical performance?*

Lastly we have asked what integration the respondents think the most significant factor affecting logistical performance. According to the table 4.4, 35.3% of the respondents answered that integration is the most significant factor and Technology and Planning Integration is chosen as the second most significant factor.

| What do you think the most significant factor affecting logistical performance? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **Internal Integration** | 35.3% | 12 |
| **Material/Service Supplier Integration** | 17.6% | 6 |
| **Technology and Planning Integration** | 23.5% | 8 |
| **Measurement Integration** | 11.8% | 4 |
| **Relationship Integration** | 11.8% | 4 |
| | ***answered question*** | **34** |
| | ***skipped question*** | **1** |

Although Internal integration and technology & Planning integration are chosen as the major key factors affecting the logistical performance by the respondents, the respondents also chose that other types of integrations as affecting factors to the performance.

So we can perceive that there is no a single integration affecting the performance index in Samsung EDC but each integration factor somehow affects to the logistical performance either directly or indirectly.

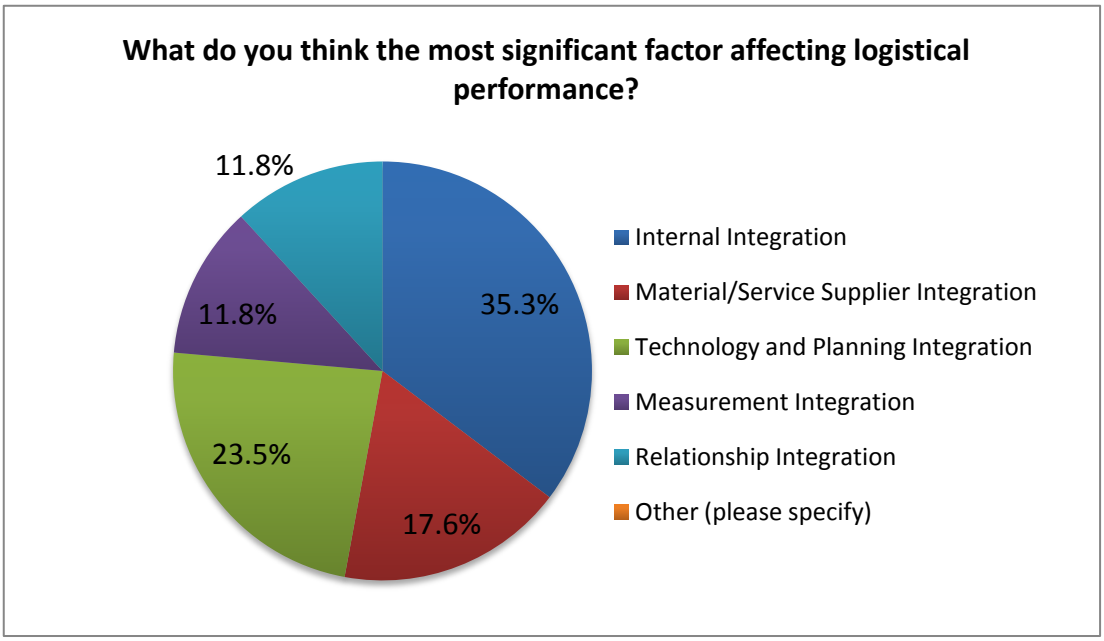
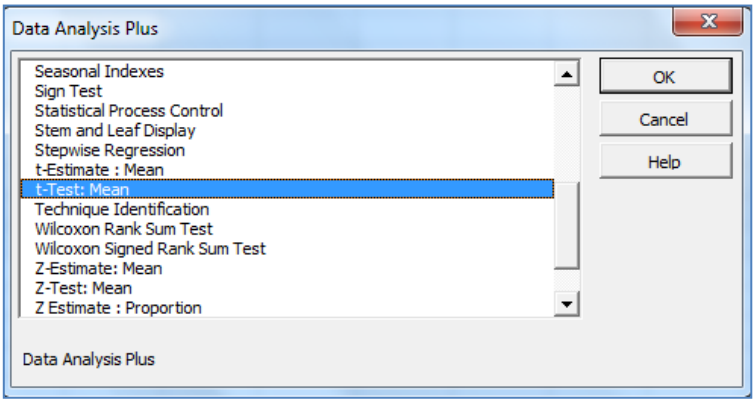



**Table 4.4** Result for the screening question 4

### 4.3 Survey results for main questions

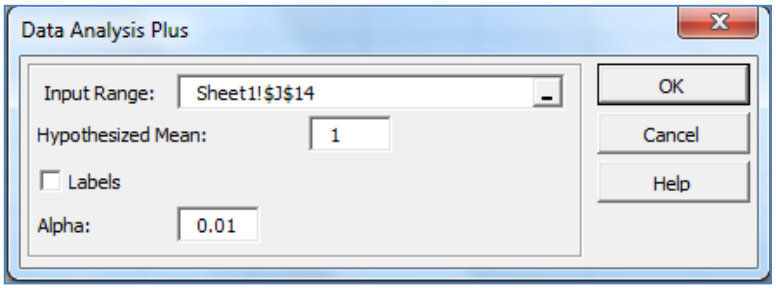
We have performed the survey with 10 main questions to get to know how the people involved in the logistics integration of Samsung EDC think the effectiveness of the integration. The results from the statistical analysis by using t-Test in statistics function of Excel 2007 like Figure 4.1 for proving whether this survey results is significant or not.




**(Figure 4.1)** Excel 2007 Data analysis plus: t-Test: Mean

After that, the survey results are ranged and hypothesized mean as 0 are input in

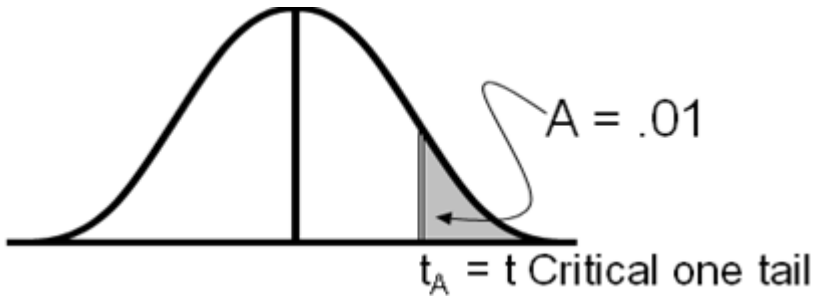
the data analysis plus. Lastly alpha value as 0.01 is input which means that this result is verified with 1% of significance level as Figure 4.2




**(Figure 4.2)** Excel 2007 Data analysis plus: t-Test value input

Then verify our hypothesis comparing the calculated t Stat from Excel against t Critical One tail value which is 1% of significance level in Figure 4.3
If t Stat is greater than t Critical one tail value then we reject null hypothesis (H0) in favour of alternative hypothesis (H1)

H0: (MU1-MU2) = 0 (No influence)
H1: (MU1-MU2) > 0 (Positively influencing)




**(Figure 4.3)** Sample's T- distribution with critical value

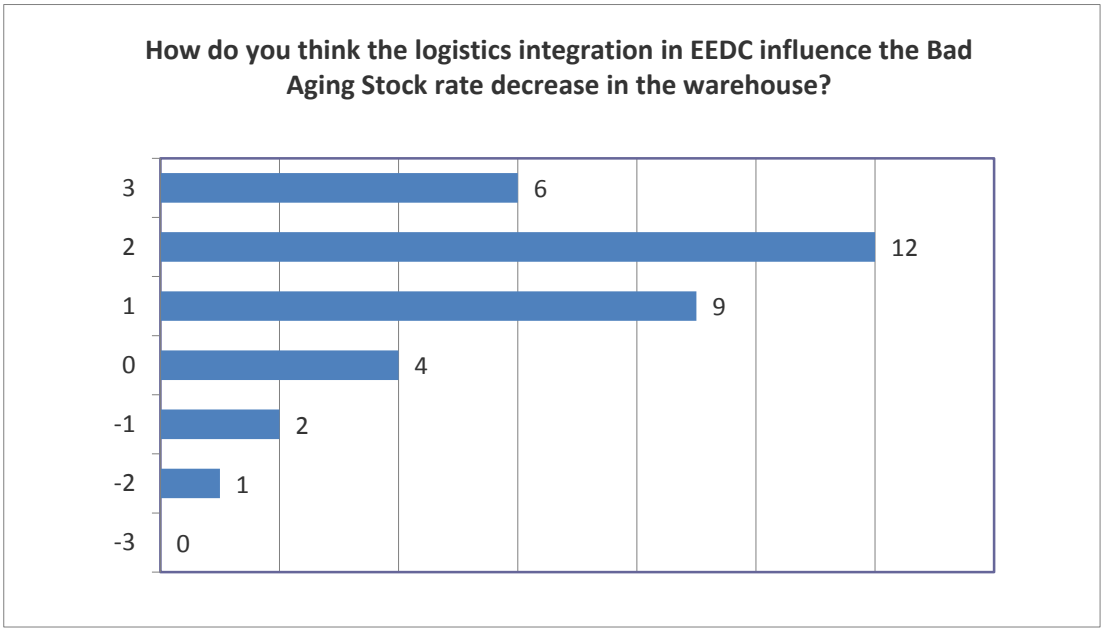
### *4.3.1 Question 1. Bad Aging Stock Rate*

Through the literature review we already learned that internal integration is also associated with better inventory management. Better internal information sharing and communication lead to reduced inventories as product flow is expedited such that inventory turns and order fill capacity is maximized. (Stank, Keller, Closs, 2005) The purpose of the survey question is to check if the independent variables from the survey in the EDC also show the same result that the logistics integration in

Samsung EDC also influenced positively to the bad aging stock rate improvement.

According to the table 4.5, T-test results show that the value of the test statistic is 6.42 and the one tail p-value is 0.00. We observe that the p-value of the test is small (and the test statistic falls into the rejection region). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the bad Aging Stock rate decrease in Samsung EDC.

| **How do you think the logistics integration in EEDC influence the Bad Aging Stock rate decrease in the warehouse?** | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 2.9% | 1 |
| **-1** | 5.9% | 2 |
| **0** | 11.8% | 4 |
| **1** | 26.5% | 9 |
| **2** | 35.3% | 12 |
| **3** | 17.6% | 6 |
| ***answered question*** | | **34** |
| ***skipped question*** | | **1** |



| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.38** | t Stat | **6.42** |
| Sample standard deviation | **1.26** | P(T<=t) one-tail | **0.00** |
| Sample size | **34** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

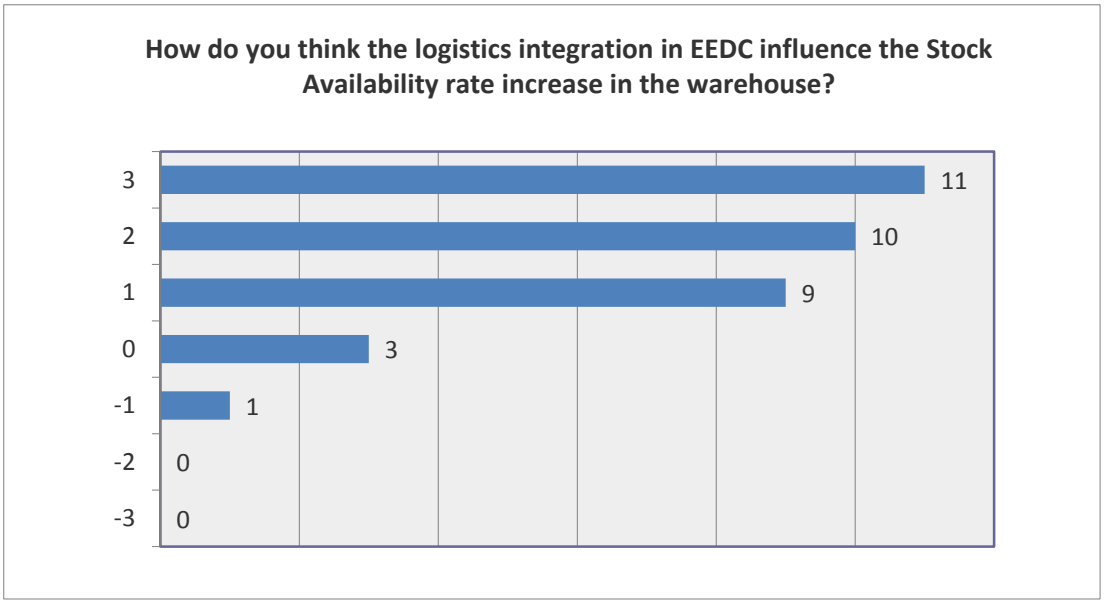
**Table 4.5** Survey result for the question 1

### *4.3.2 Question 2. Stock Availability rate*

For a logistics company, to decrease their bad aging stock and increase stock availability are one of the most significant issue as it's directly related with a company's cost saving and on time delivery to customers which means customer's satisfaction.

According to the table 4.6, T-test results show that the value of the test statistic is 9.55 and the one tail p-value is 0.00. In addition to that, t Stat is greater than t Critical one tail value then we reject null hypothesis (H0) in favour of alternative hypothesis (H1). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the availability rate increase in the warehouse in Samsung EDC.

| **How do you think the logistics integration in EDC influence the Stock Availability rate increase in the warehouse?** | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 0.0% | 0 |
| **-1** | 2.9% | 1 |
| **0** | 8.8% | 3 |
| **1** | 26.5% | 9 |
| **2** | 29.4% | 10 |
| **3** | 32.4% | 11 |
| | ***answered question*** | **34** |
| | ***skipped question*** | **1** |




| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.79** | t Stat | **9.55** |
| Sample standard deviation | **1.09** | P(T<=t) one-tail | **0.00** |
| Sample size | **34** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | 2.73 |

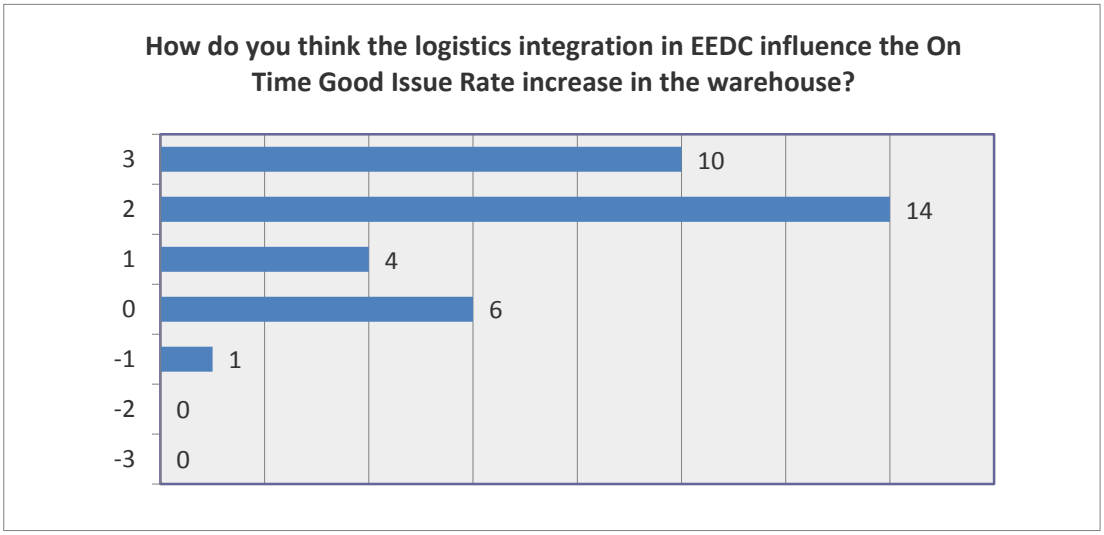
**Table 4.6** Survey result for the question 2

### *4.3.3 Question 3. On Time Good Issue Rate*

According to the table 4.7, t Stat as 8.99 is greater than t Critical one tail value which is 2.44 then we reject null hypothesis (H0) in favour of alternative hypothesis (H1). We also observe that the p-value of the test is small (and the test statistic falls into the rejection region).

As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the On Time Good Issue Rate improvement in the warehouse in Samsung EDC.

| How do you think the logistics integration in EEDC influence the On Time Good Issue Rate increase in the warehouse? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 0.0% | 0 |
| **-1** | 2.9% | 1 |
| **0** | 17.1% | 6 |
| **1** | 11.4% | 4 |
| **2** | 40.0% | 14 |
| **3** | 28.6% | 10 |
| | ***answered question*** | **35** |
| | ***skipped question*** | **0** |



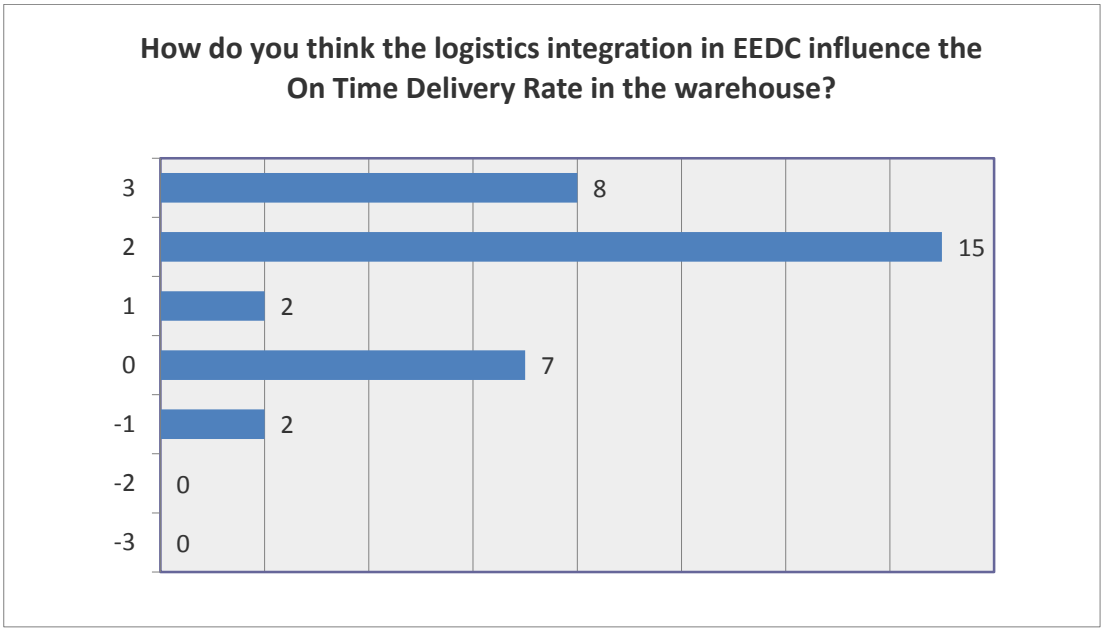

| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.74** | t Stat | **8.99** |
| Sample standard deviation | **1.15** | P(T<=t) one-tail | **0.00** |
| Sample size | **35** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

**Table 4.7** Survey result for the question 3

### *4.3.4 Question 4. On Time Delivery Rate*

According to the table 4.8, the T-test results show that the value of the test statistic is 7.51 and the one tail p-value is 0.00. In addition to that, t Stat is greater than t Critical one tail value (2.44) then we reject null hypothesis (H0) in favour of alternative hypothesis (H1). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the On Time Delivery Rate improvement in Samsung EDC.

| How do you think the logistics integration in EEDC influence the On Time Delivery Rate in the warehouse? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 0.0% | 0 |
| **-1** | 5.9% | 2 |
| **0** | 20.6% | 7 |
| **1** | 5.9% | 2 |
| **2** | 44.1% | 15 |
| **3** | 23.5% | 8 |
| | ***answered question*** | **34** |
| | ***skipped question*** | **1** |



| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.59** | t Stat | **7.51** |
| Sample standard deviation | **1.23** | P(T<=t) one-tail | **0.00** |
| Sample size | **34** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

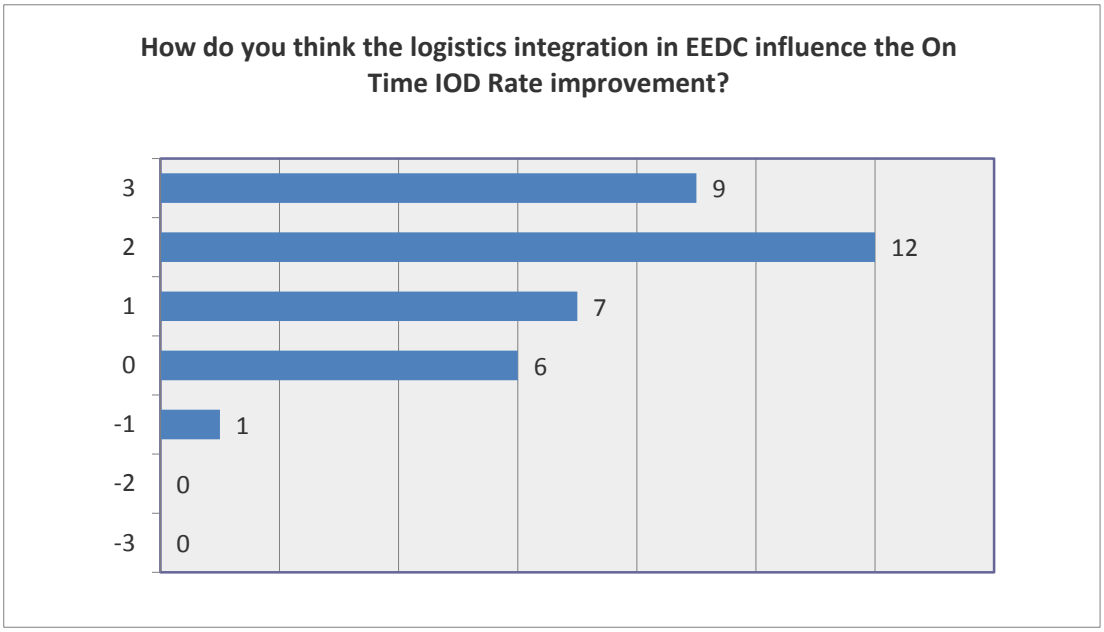
**Table 4.8** Survey result for the question 4

### *4.3.5 Question 5. On Time IOD Rate*

According to the table 4.9, the T-test results show that the value of the test statistic is 8.45 and the one tail p-value is 0.00. We observe that the p-value of the test is small (and the test statistic falls into the rejection region).

As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the On Time IOD rate improvement in Samsung EDC.

| How do you think the logistics integration in EEDC influence the On Time IOD Rate improvement? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 0.0% | 0 |
| **-1** | 2.9% | 1 |
| **0** | 17.1% | 6 |
| **1** | 20.0% | 7 |
| **2** | 34.3% | 12 |
| **3** | 25.7% | 9 |
| | ***answered question*** | **35** |
| | ***skipped question*** | **0** |




| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.63** | t Stat | **8.45** |
| Sample standard deviation | **1.14** | P(T<=t) one-tail | **0.00** |
| Sample size | **35** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

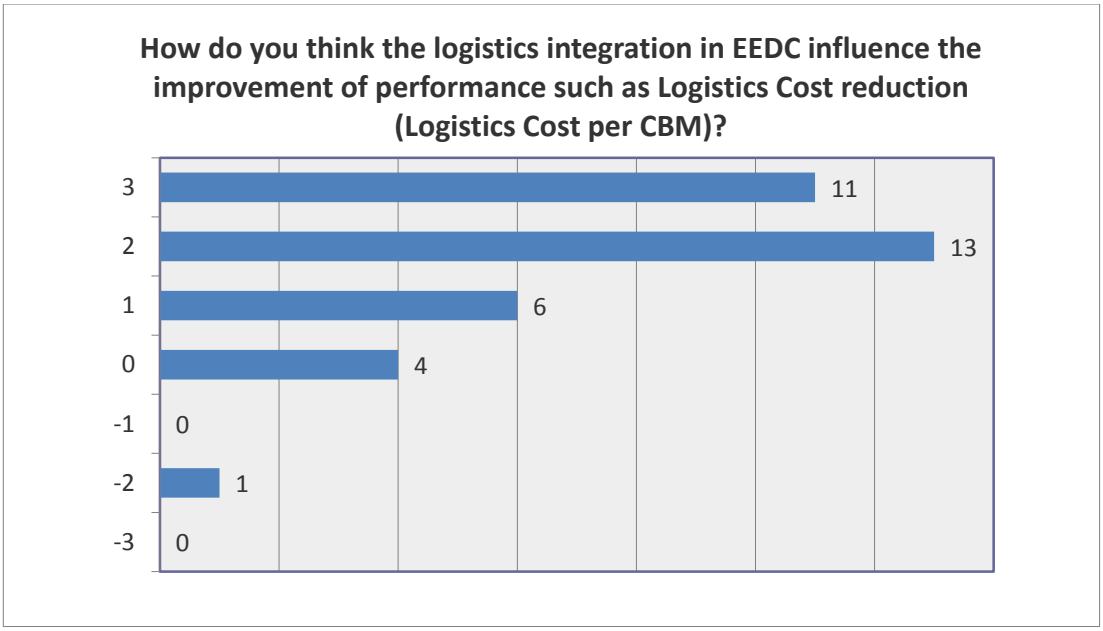
**Table 4.9** Survey result for the question 5

### *4.3.6 Question 6. Logistics Cost reduction*

According to the table 4.10, the T-test results show that the value of the test statistic is 9.00 and the one tail p-value is 0.00. In addition to that, t Stat is greater than t Critical one tail value (2.44) then we reject null hypothesis (H0) in favor of alternative hypothesis (H1).

As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the Logistics Cost reduction in Samsung EDC.

| How do you think the logistics integration in EEDC influence the improvement of performance such as Logistics Cost reduction (Logistics Cost per CBM)? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 2.9% | 1 |
| **-1** | 0.0% | 0 |
| **0** | 11.4% | 4 |
| **1** | 17.1% | 6 |
| **2** | 37.1% | 13 |
| **3** | 31.4% | 11 |
| | ***answered question*** | **35** |
| | ***skipped question*** | **0** |
| | | |



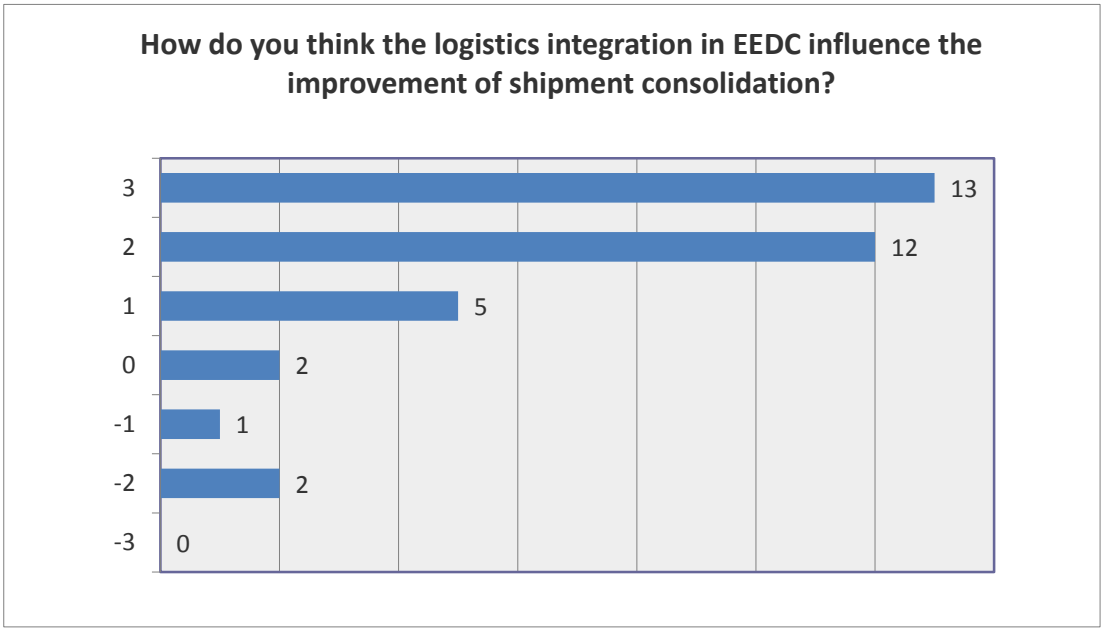

| t-Test of a Mean | | | |
|---|---|---|---|
| Sample mean | **1.80** | t Stat | **9.00** |
| Sample standard deviation | **1.18** | P(T<=t) one-tail | **0.00** |
| Sample size | **35** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

**Table 4.10** Survey result for the question 6

### *4.3.7 Question 7. Improvement of consolidation*

According to the table 4.11, the T-test results show that the value of the test statistic is 7.67 and the one tail p-value is 0.00. We observe that the p-value of the test is small (and the test statistic falls into the rejection region). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the Improvement of consolidation in Samsung EDC.

| How do you think the logistics integration in EEDC influence the improvement of shipment consolidation? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 5.7% | 2 |
| **-1** | 2.9% | 1 |
| **0** | 5.7% | 2 |
| **1** | 14.3% | 5 |
| **2** | 34.3% | 12 |
| **3** | 37.1% | 13 |
| | ***answered question*** | **35** |
| | ***skipped question*** | **0** |



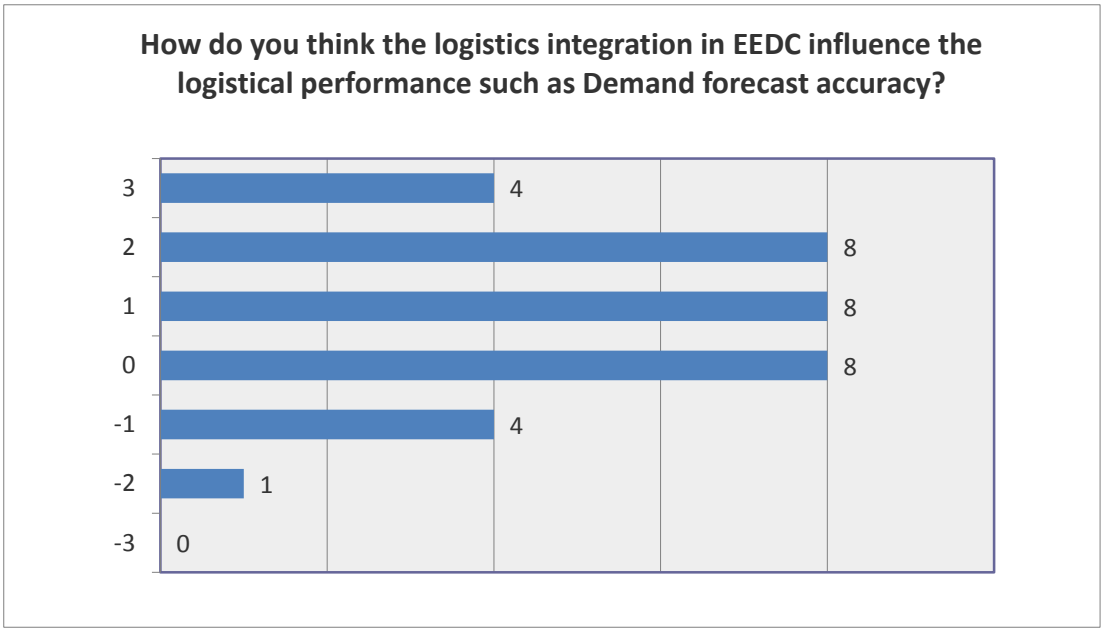
| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.80** | t Stat | **7.67** |
| Sample standard deviation | **1.39** | P(T<=t) one-tail | **0.00** |
| Sample size | **35** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

**Table 4.11** Survey result for the question 7

### *4.3.8 Question 8. Demand forecast accuracy*

According to the table 4.12, the T-test results show that the value of the test statistic is 3.92 and the one tail p-value is 0.00. In addition to that, t Stat is greater than t Critical one tail value (2.45) then we reject null hypothesis (H0) in favor of alternative hypothesis (H1). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the Demand forecast accuracy in Samsung EDC.

| How do you think the logistics integration in EEDC influence the logistical performance such as Demand forecast accuracy? | | |
|---|---|---|
| Answer Options | Response Percent | Response Count |
| -3 | 0.0% | 0 |
| -2 | 3.0% | 1 |
| -1 | 12.1% | 4 |
| 0 | 24.2% | 8 |
| 1 | 24.2% | 8 |
| 2 | 24.2% | 8 |
| 3 | 12.1% | 4 |
| *answered question* | | 33 |
| *skipped question* | | 2 |



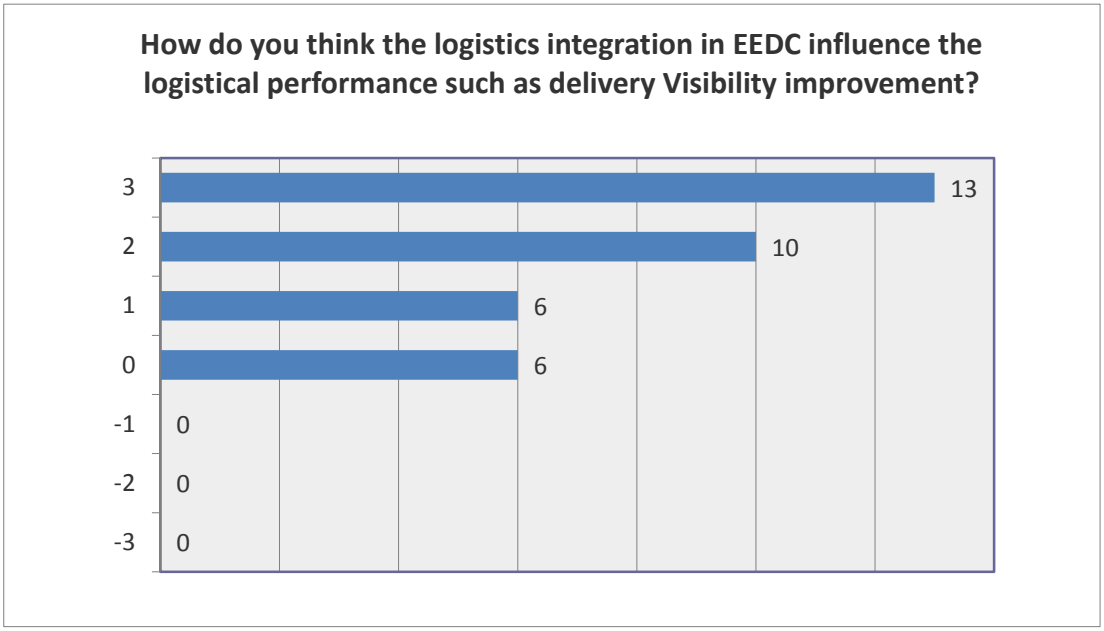

| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | 0.91 | t Stat | 3.92 |
| Sample standard deviation | 1.33 | P(T<=t) one-tail | 0.00 |
| Sample size | 33 | t Critical one-tail | 2.45 |
| Hypothesized mean | 0 | P(T<=t) two-tail | 0.00 |
| Alpha | 0.01 | t Critical two-tail | 2.74 |

**Table 4.12** Survey result for the question 8

### *4.3.9 Question 9. Delivery Visibility of shipments*

According to the table 4.13, the T-test results show that the value of the test statistic is 9.85 and the one tail p-value is 0.00. We observe that the p-value of the test is small (and the test statistic falls into the rejection region). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration affected positively to the Improvement of Advance Delivery Visibility in Samsung EDC.

| How do you think the logistics integration in EEDC influence the logistical performance such as delivery Visibility improvement? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 0.0% | 0 |
| **-1** | 0.0% | 0 |
| **0** | 17.1% | 6 |
| **1** | 17.1% | 6 |
| **2** | 28.6% | 10 |
| **3** | 37.1% | 13 |
| | ***answered question*** | **35** |
| | ***skipped question*** | **0** |



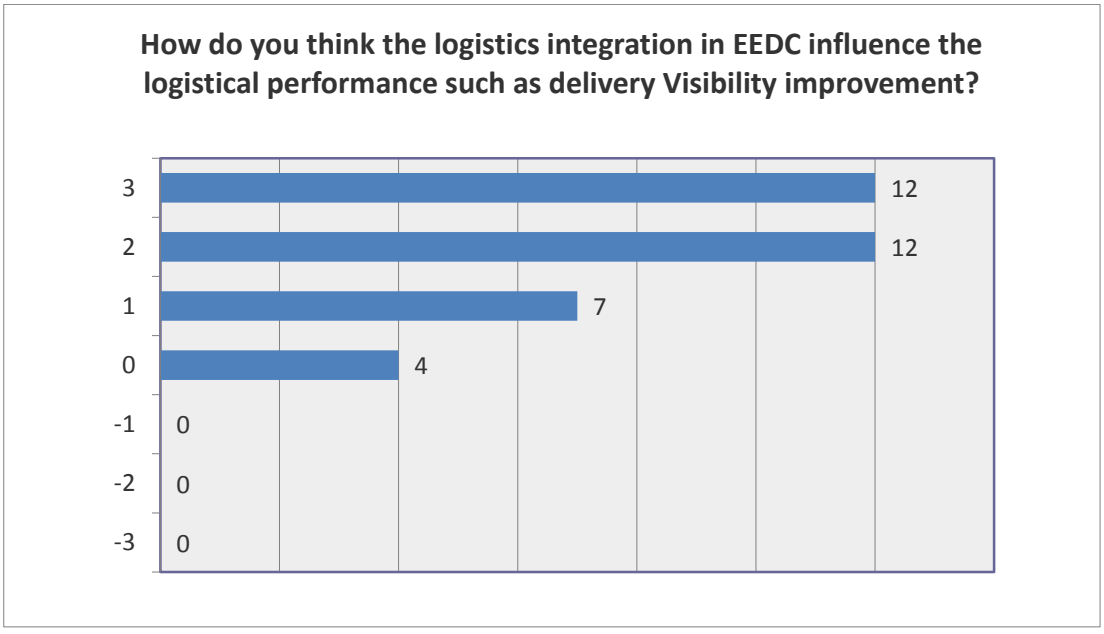

| t-Test of a Mean | | | |
|---|---|---|---|
| Sample mean | **1.86** | t Stat | **9.85** |
| Sample standard deviation | **1.12** | P(T<=t) one-tail | **0.00** |
| Sample size | **35** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

**Table 4.13** Survey result for the question 9

### *4.3.10 Question 10. benefit of Logistics Cost due to economies of scale*

According to the table 4.14, the t-test results show that the value of the test statistic is 11.20 and the one tail p-value is 0.00. We observe that the p-value of the test is small (and the test statistic falls into the rejection region). As a result, we conclude that there is sufficient evidence with a 1% significance level to infer that the logistics integration the benefit of Logistics Cost due to economies of scale.

| How do you think the logistics integration get the benefit of Logistics Cost due to economies of scale? | | |
|---|---|---|
| **Answer Options** | **Response Percent** | **Response Count** |
| **-3** | 0.0% | 0 |
| **-2** | 0.0% | 0 |
| **-1** | 0.0% | 0 |
| **0** | 11.4% | 4 |
| **1** | 20.0% | 7 |
| **2** | 34.3% | 12 |
| **3** | 34.3% | 12 |
| | ***answered question*** | **35** |
| | ***skipped question*** | **0** |



| t-Test of a Mean | | | |
|---|---|---|---|
| | | | |
| Sample mean | **1.91** | t Stat | **11.20** |
| Sample standard deviation | **1.01** | P(T<=t) one-tail | **0.00** |
| Sample size | **35** | t Critical one-tail | **2.44** |
| Hypothesized mean | **0** | P(T<=t) two-tail | **0.00** |
| Alpha | **0.01** | t Critical two-tail | **2.73** |

**Table 4.14** Survey result for the question 10

### 4.4 Summarization of the survey result

We have performed nine main questions asking the relationship between the logistical performance and logistics integration and the result has been analyzed by using t-test in the data analysis plus of excel 2007. As can be seen in the table 4.15, t statistic values and P values are calculated with 1% of significant ratio

Based on the values, we figured out that we need to reject null hypothesis and support alternative hypothesis interring that the logistics integration influences positively to the logistical performance improvement in Samsung EDC. Please see Summarization of the t-test result in the table 4.15.

| No | Index concepts | t Stat | P-Value (One tail) | Results |
|---|---|---|---|---|
| Q1 | **Bad Aging Stock Rate** | 6.41934787 | 0.00000014 | Support $H_1$ |
| Q2 | **Stock Availability rate** | 9.55488937 | 0.00000000 | Support $H_1$ |
| Q3 | **On Time Good Issue Rate** | 8.99395933 | 0.00000000 | Support $H_1$ |
| Q4 | **On Time Delivery Rate** | 7.50596952 | 0.00000001 | Support $H_1$ |
| Q5 | **On Time IOD Rate** | 8.45297471 | 0.00000000 | Support $H_1$ |
| Q6 | **Logistics Cost reduction** | 9.00000000 | 0.00000000 | Support $H_1$ |
| Q7 | **Improvement of consolidation** | 7.66644574 | 0.00000000 | Support $H_1$ |
| Q8 | **Demand forecast accuracy** | 3.92232270 | 0.00021772 | Support $H_1$ |
| Q9 | **Advance Delivery Visibility** | 9.85194452 | 0.00000000 | Support $H_1$ |

**Table 4.15** Summarization of the t-test result

# Chapter 5 Survey Analysis

## 5.1 Introduction

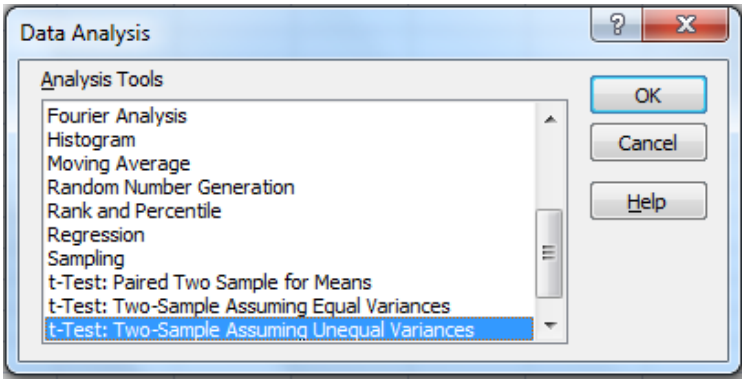
In this chapter, the data mining results and the practical example currently in use in Samsung EDC will be compared with the previous survey results. The result of the survey performed in the previous chapter shows that the logistics integration influenced to the improvement of the logistical performance so enough to reject null hypothesis.

Finally the comparison between survey results and data mining and examples regarding the nice logistical performance indexes will allow us to conclude the effectiveness after the logistics integration in Samsung EDC.

## 5.2 Executing the data collections & analysis

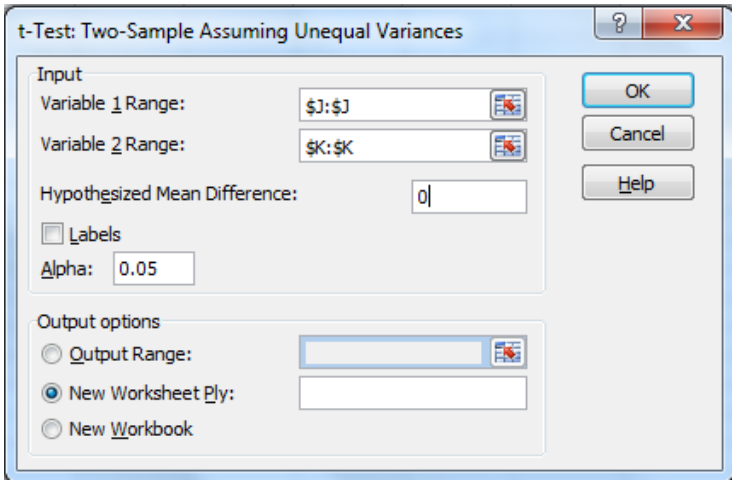
We have analyzed main logistical performance index and get results by comparing the effectiveness of logistics integration as following. The results from the t-Test in statistics function in Excel 2007 (see Figure 4.1) was analyzed in order to prove whether this survey results is significant or not. At the same time, the data mining for this period between Jan 2007 to May 2010 has been executed and the collection of the data has been carried out through either from the Samsung internal ERP (SAP) or GLP (Global Logistics performance) system which covers all product line handled by Samsung Electronics.

Firstly we have checked if the variance of the 2 samples are the same or different by using F stat. Once the F stat is in the range of rejection area, we can reject H0 which means Groups 1 and 2 have a different variance. If it turns out that the groups 1 and 2 have a different variance, we can use t-Test of the Difference between Two Means (Unequal-Variances) like Figure 5.1




**(Figure 5.1)** Excel 2007 Data analysis plus: t-Test: Mean

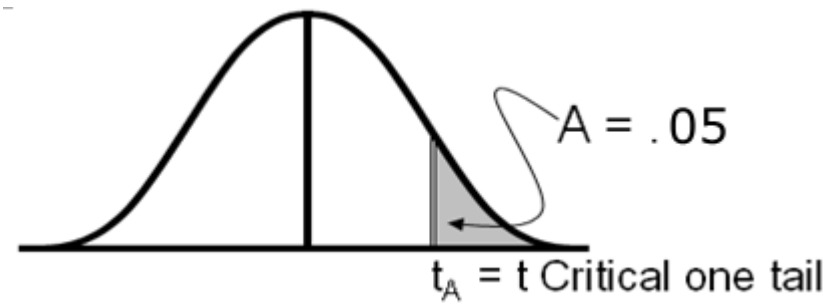
After that, the data mining results are ranged and hypothesized mean as 0 are input in the data analysis plus and alpha value as 0.05 is input which means that this result is verified with 5% of significance level as Figure 5.2




**(Figure 5.2)** Excel 2007 Data analysis plus: t-Test value input

Then verify our hypothesis comparing the calculated t Stat from Excel against t Critical One tail value which is 5% of significance level in Figure 5.3
If t Stat is greater than t Critical one tail value then we reject null hypothesis (H0) in favour of alternative hypothesis (H1)

H0: (MU1-MU2) = 0 (No influence)
H1: (MU1-MU2) > 0 (Positively influencing)




**(Figure 5.3)** Sample's T- distribution with critical value

## 5.3 The comparison between survey results and data mining / examples

Hereafter, the nine questions concerning the logistical performance index including data mining and practical examples in Samsung EDC will be analyzed. As we are comparing the survey results with the real data analysis in ERP systems or proving examples, as a final point we can make certain that the data analysis also corresponding with the survey results.

### *5.3.1. Q1. Bad Aging Stock Rate (≥ 60 days)*

#### *5.3.1.1. Data Mining result*

"The aging stock in Samsung EDC means the total portion of stock which has been stored in the W/H (Warehouse) more than 60 days without selling to customers due to slow business in the market. The question aimed in this study is to analyze statistically if the logistics integration positively affects on the improvement of aging stock rate in the W/H after of Logistics integration via the hypothesis testing. The data since 2007 has been collected from Samsung GLP (Global Logistics Performance) system and the 135 samples are used for t-test." (Jang, 2010) See Appendix1 (a)

Firstly, we have checked if the variance of the 2 samples are the same or different by using F stat and the result shows that as the F-Test (4.48) is in the range of rejection area, we can reject H0 (null hypothesis) so the groups 1 and 2 have a different variance. See Appendix1 (c)

Then after t-Test, as the t-stat value 3.22 which is greater than the t Critical one tail value (1.628) like table 5.1, we can reject null hypothesis (H0) in favour of

alternative hypothesis ($H_1$). It means that there is enough proof to insist that there is a positive influence on the improvement of the bad aging stock rate by the logistics integration in Samsung EDC with 95% confidential level. See Appendix1 (d)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.026 | 0.012 | t Stat | 3.22 |
| Variance | 0.002 | 0.001 | P(T<=t) one-tail | 0.0007 |
| Sample size | 135 | 126 | t Critical one-tail | 1.6528 |
| Degrees of freedom | 193.84 | | P(T<=t) two-tail | 0.0015 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9723 |
| Alpha | 0.05 | | | |

**(Table 5.1)** T-test of Bad Aging Stock Rate

**(Source)** Jang, “Analysis of Logistics integration effectiveness based on Samsung model”, 2010

In addition, we can also infer from the *t-Estimate test* (Appendix1 (e)) that there is roughly 0.6 to 2.4 percent more aging stocks before the logistics integration than after the logistics integration which means the aging stock issue has been improved a lot.

### *5.3.2. Q2. Stock (Inventory) Availability rate*

#### *5.3.2.1. Data Mining result*

Stock availability means the total number of available stocks for sales. In case of blocked goods such as returned goods, damaged goods in transit are not part of available stocks. (Jang, 2010) The higher stock availability rate means the better logistics W/H logistics operation. The question is about how the centralized distribution center affects to the stock availability rate in the Samsung EDC. The data since 2007 has been collected from Samsung internal ERP system so called SAP and the 118 sample data are used for t-test. See Appendix2 (a)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.991 | 0.994 | t Stat | -1.96 |
| Variance | 0.000 | 0.000 | P(T<=t) one-tail | 0.0259 |
| Sample size | 83 | 118 | t Critical one-tail | 1.6526 |

| | | | | |
|---|---|---|---|---|
| Degrees of freedom | 197.86 | | P(T<=t) two-tail | 0.0518 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9721 |
| Alpha | 0.05 | | | |

**(Table 5.2)** T-test of stock availability

**(Source)** Jang, “Analysis of Logistics integration effectiveness based on Samsung model”, 2010

Then after t-Test, as P value (0.025) is smaller than the significance level (0.05), there is not enough evidence to support H0 (No influence). (See Table 5.2) It means that there is enough proof to insist that there is a positive influence (H1) on the improvement of the stock availability rate by the logistics integration in Samsung EDC with 95% confidential level. See Appendix2 (d)

The t-estimate test also shows that there is roughly 0.6 percent less stock availability before the centralization of the logistics distribution center, than after the logistics integration. It means that the stock availability has been enhanced and there is less possibility of lack of stocks for sales at this instant. See appendix2 (e)

### *5.3.3. Q3. OTG Rate (Planned GI – Actual GI <=1)*

#### *5.3.3.1. Data Mining result*

OTG (On Time Good Issue) is one of the main logistical performance index measured in a Logistics Company. It’s about how accurately shipments are dispatched in W/H as its original planned time. It is very important as it’s directly related with the on time delivery index for customers. The data since 2007 has been collected from Samsung GLP (Global Logistics Performance) system and the 118 sample data are used for t-test. See Appendix3 (a)

After t-Test, as P value (0.0074) is smaller than the significance level (0.05), we can infer that there is a weak to support H0 (See Table 5.3) It means that there is enough proof to insist that there is a positive influence (H1) on the improvement of the on time good issue in the distribution centre by the logistics integration in Samsung EDC with 95% confidential level. See Appendix2 (d)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.986 | 0.999 | t Stat | -2.49 |
| Variance | 0.002 | 0.000 | P(T<=t) one-tail | 0.0074 |
| Sample size | 83 | 128 | t Critical one-tail | 1.6636 |
| Degrees of freedom | 82.38 | | P(T<=t) two-tail | 0.0149 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9893 |
| Alpha | 0.05 | | | |

**(Table 5.3)** T-test of on time good issue

**(Source)** Jang, “Analysis of Logistics integration effectiveness based on Samsung model”, 2010

What's more, there is roughly 0.25 to 2.3 percent less On Time Good Issue (OTG) rate than after the logistics integration. Consequently we can say that the OTG index has been improved. See appendix3 (e)

#### *5.3.3.2. Supporting example (Cut-off rule)*

In chapter 2, we have seen that the logistical performance index has improved a lot after the logistics integration. In this section, we will see how the performance was improved especially regarding on time G/I and on time outbound delivery index by studying the standard process of EDC in Samsung model. See figure 5.4

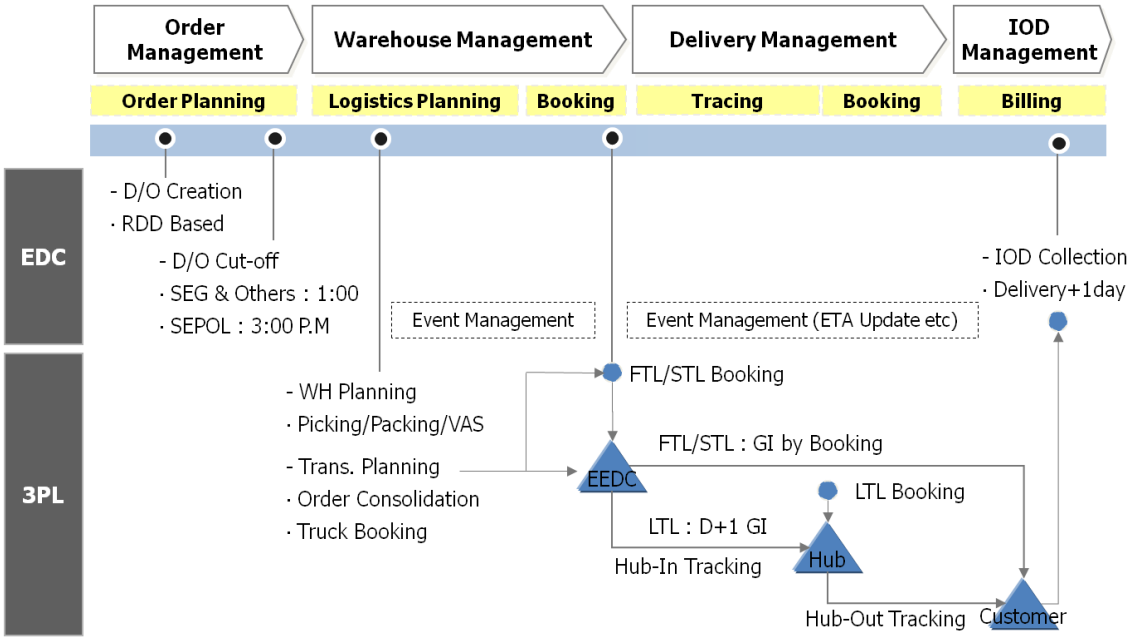
Basically the EDC process is consisted of 4 different stages as order management, W/H management, delivery management and finally information of delivery management. First of all, in the order management stage the concept what EDC adjusted in the process to handle lots of orders created by each subsidiary was a cut off rule. Before explain the cut off concept in detail, we need to define what the cut off rule is.

According to the operation manual in Samsung, Cut off is defined as an internal agreement with customers to deliver ordered goods in agreed delivery lead-time. For example, once the order is placed before the cut off time (mostly 3pm), EDC guarantees to deliver the order in the agreed lead time (in mostly 2 days). However once the order is placed after the cut off, then the delivery date to the customer will be the agreed lead-time plus 1 day.

As each subsidiary’s location is different (some is closer and some is further

from DC), EDC adjusted a different cut off time. For instance in case of Poland, the cut off is 3pm. However in case of Germany, the cut off is 1pm as they are located further from the DC (Slovakia).

Eventually as EDC manages the cut off rule strictly, the burden on the warehouse operation became lessen and EDC also was able to forecast how much the total amount of handling volume will be and till when and what the W/H must achieve during the day to meet the lead time to customers.




**(Figure 5.4)** EDC Standard Process (D/O Creation ~ IOD Collection)

Additionally, as each subsidiary has a different cut off as per the distance, the W/H also easily recognizes the priority of work like the longer the distance is, the sooner the logistics planning will be. Based on this rule, the first operational request in the first cut off is sent to the WMS via EDI and W/H starts picking and packing for those delivery orders as it can be seen in the W/H management stage which is in the 2nd stage of EDC process.

The differentiated cut off rule spreads the work load on W/H so the W/H possibly expects the work load of the day so that the operational plan can be established accordingly. As a result, delay of good issue is minimized and it leads to on time good issue performance improvement.

### *5.3.4. Q4. OTD Rate (ATA - ETA =0)*

#### *5.3.4.1. Data Mining result*

OTD (On Time Delivery) is one of the major logistical performance index measured in a Logistics Company. It's about how precisely shipments are delivered as its previously agreed with a customer which is maintained with contracted lead time. It's calculated by measuring the gap between ATA (Actual Time to arrival) and ETA (Estimated). It is very essential to manage the performance index above the target as it's directly related with the customer's satisfaction. The logic of the calculation in the Samsung EDC is defined by counting the total number of goods which are delivered on time by dividing with the total number of goods dispatched in W/H as below.

$$\text{OTD rate} = \frac{\text{Sum of goods delivered on time}}{\text{Total number of goods dispatched in the W/H}}$$

Firstly, we have checked if the variance of the 2 samples are the same or different by using F stat and the result shows that as the F-Test (0.35) is in the range of rejection area, we can reject H0 (null hypothesis) so the groups 1 and 2 have a different variance. See Appendix5 (c)

Then after t-Test, as P value (0.045) is smaller than the significance level (0.05), there is not enough evidence to support H0 (No influence). (See Table 5.4) It means that there is enough proof to insist that there is a positive influence (H1) on the improvement of the on time outbound delivery rate by the logistics integration in Samsung EDC with 95% confidential level. See Appendix5 (d)

The t-estimate test also shows that there is roughly 1 percentage less on time delivery rate before the centralization of the logistics distribution center, than after the logistics integration. It means that the on time delivery rate has been enhanced and there is less possibility of late delivery to customers. See Appendix5 (e)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.990 | 0.993 | t Stat | -1.72 |
| Variance | 0.0001 | 0.0002 | P(T<=t) one-tail | 0.0444 |
| Sample size | 60.0000 | 60.0000 | t Critical one-tail | 1.6611 |

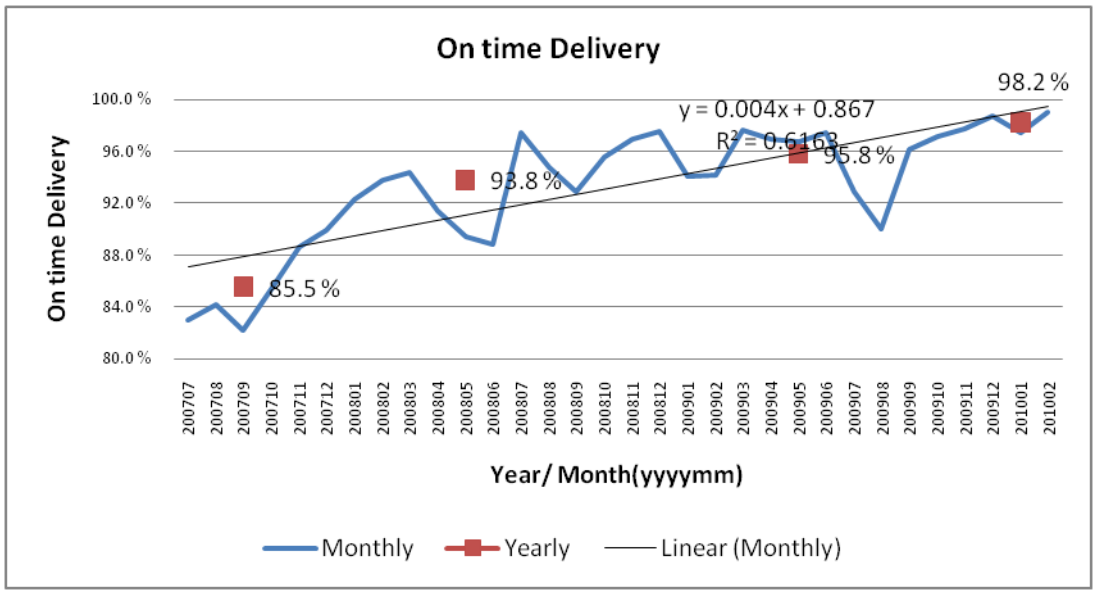
| | | | | |
|---|---|---|---|---|
| Degrees of freedom | 95.53 | | P(T<=t) two-tail | 0.0888 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9853 |
| Alpha | 0.05 | | | |

**(Table 5.4)** T-test of On Time Delivery Rate

Furthermore, the linear regression trend also shows that the on time delivery rate has been increasing.

**The linear regression of On Time delivery index: y= 0.004x + 0.867**

As can be seen in the linear regression, the on time delivery performance is being improved as the slope value is 0.004 which is positive after the logistics integration. In addition, $R^2$ clarifies that the portion which covered from x variables are 61.6%%.




**(Figure 5.5)** On Time Delivery Trend

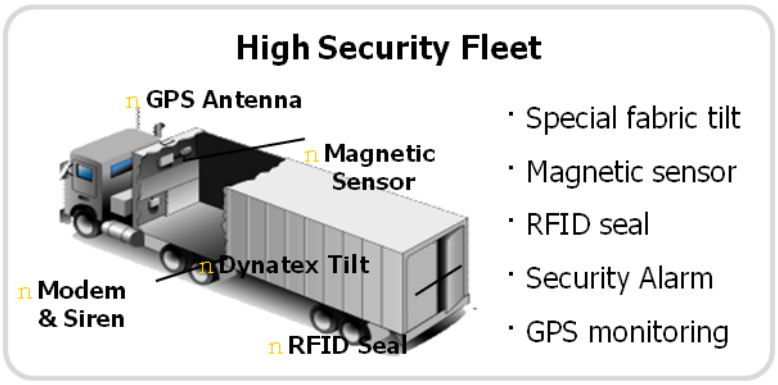
### *5.3.4.2. Supporting example (Advanced visibility system)*

We have seen in chapter 2 that OTD performance which is directly related to customer satisfaction has improved a lot after the logistics integration. In this section, we will study how the performance could be improved by the advanced visibility system. To discuss the advanced visibility system, we need to define how the OTD is measured.

OTD (On Time Outbound delivery) performance is measured by measuring the gap between customer's RDD (Requested Delivery Date) and actual delivery date so called IOD (Information of Delivery date). Once RDD is the same as IOD, we define that the shipment has delivered to the customer on time. However once the IOD date of the shipment is different from the RDD, then we define that the shipment has not delivered to the customer on time defined as a failure of on time delivery (late/early delivery).

When warehouses managed separately by each subsidiary were centralized by EDC, one of the biggest concerns by the subsidiaries was to lose control of tracking and tracing regarding shipments as the distance from DC to customers would become definitely longer than where they used to be and the dedicated shipment handling would be no longer possible.

However the advanced track and trace system made more strict management of shipments possible and the relationship with customers even became more strengthen as the open visibility system allows customers to check where their shipments are whenever the customers would like to check through the provided SAP Terminal.

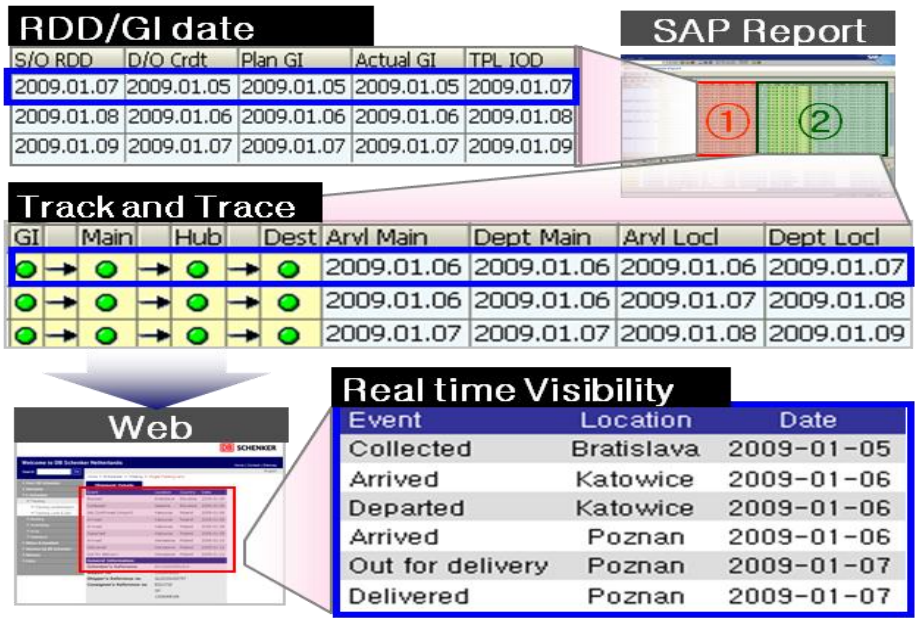



**(Figure 5.6)** High Security Fleet

See figure 5.6. More than 80% of trucks are GPS equipped and have a high security functions in Samsung. Although HSF is 20% more expensive than normal TILT truck, economies of scale by the centralized DC allowed securing HSF with lower price. The GPS equipped trucks sends track and trace (T&T) information to 3PL and it is re-transferred to SAP in Samsung via EDI. As a result, it shows where the shipments are in real time. See figure 5.7.

For example once the shipments arrive at one of the hubs on the way to customers, the color of the icon becomes green and once it is in transit between DC

and Hub or Hub and Hub, it is marked as an arrow as below. So once the icon does not change to green color during the designated time period, the system shows a warning signal with red mark so that the person in charged in DC could directly contact the carrier to check the status of the delivery and update the information of the shipment for customers so that the customers could reschedule the RDD and W/H to be prepared for unloading. See figure 5.7.




**(Figure 5.7)** Advanced track and trace

Eventually, the enhanced visibility system and the use of HSF realized by the centralized DC have improved the OTD performance and have a positive impact on protecting theft and customer satisfaction.

### *5.3.5. Q5. On Time IOD rate*

On Time IOD rate is one of the most important logistical performance indexes for the electronics companies such as Samsung as it is directly related with the accurate sales amount recognizing during the entire month and Samsung makes an accrual based on the IOD (Information of delivery) which are transferred via EDI.

In Samsung EDC, once the information of the delivery (IOD) is transferred to Samsung EDC system (SAP) within 24hrs after the actual shipment delivery to customers, it's calculated as a part of on time IOD rate.

According to the t-Test, as P value (0.0109) is smaller than the significance level

(0.05), there is not enough evidence to support H0 (No influence). (See Table 5.5) It means that there is enough proof to insist that there is a positive influence (H1) to the on time IOD rate by the logistics integration in Samsung EDC with 95% confidential level. Besides, the t-estimate test also shows that there is roughly 2 percent less on time IOD rate before the logistics integration. It means that the on time IOD rate has improved a lot after the integration. See appendix7 (e)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.979 | 0.992 | t Stat | -2.35 |
| Variance | 0.0013 | 0.0002 | P(T<=t) one-tail | 0.0109 |
| Sample size | 50.0000 | 49.0000 | t Critical one-tail | 1.6686 |
| Degrees of freedom | 65.93 | | P(T<=t) two-tail | 0.0219 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9971 |
| Alpha | 0.05 | | | |

**(Table 5.5)** T-test of on time IOD rate

### *5.3.6. Q6. Logistics Cost reduction*

#### *5.3.6.1. Data Mining result*

We have downloaded the logistics cost trend raw data since 2007 in order to analyze how the logistics cost has been changed by the logistics integration. The definition of the logistics cost in the Samsung EDC is sum of transportation cost and W/H cost.

As the volume of each month is rapidly changed due to the economics condition, the logistics cost per volume has been used in order to avoid any biased result. The unit of the volume here is cubic meter. In addition, we will define the moment when the independent variables start to affect as a July 2008 when the logistics operation was integrated.

Then after t-Test, as P value (0.0005) is smaller than the significance level (0.05), there is not enough evidence to support H0 (No influence). (See Table 5.6) It means that there is enough proof to insist that there is a positive influence (H1) on the cost reduction by the logistics integration in Samsung EDC with 95% confidential level.

Besides, the t-estimate test also shows that there is roughly between 4.5 and 15

euro less cost per cubic meter spent after the logistics integration. It means that the logistics cost been reduced a lot after the integration. See appendix6 (e)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 68.005 | 58.256 | t Stat | 3.89 |
| Variance | 53.7284 | 32.6039 | P(T<=t) one-tail | 0.0005 |
| Sample size | 12.0000 | 18.0000 | t Critical one-tail | 1.7291 |
| Degrees of freedom | 19.62 | | P(T<=t) two-tail | 0.0010 |
| Hypothesized difference | 0 | | t Critical two-tail | 2.0930 |
| Alpha | 0.05 | | | |

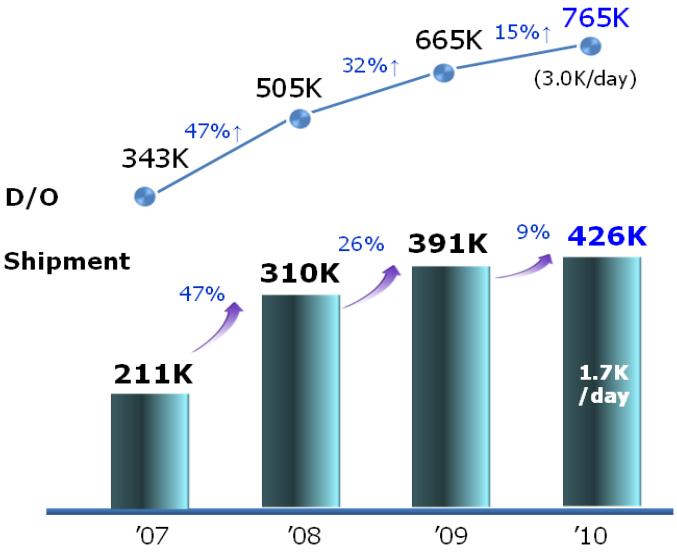
**(Table 5.6)** T-test of logistics cost per cubic meter

### *5.3.7. Q7. Improvement of Consolidation*

#### *5.3.7.1. Data Mining result*

Consolidation is an activity to group a number of delivery orders transported to the same destination. In a narrow meaning, the same destination could be customers located nearby but in a broader meaning, it could be the same postal code zone. In terms of a logistics Company, it is more benefit to load more shipments on a less number of trucks as they pay based on the number of truck used for transporting.

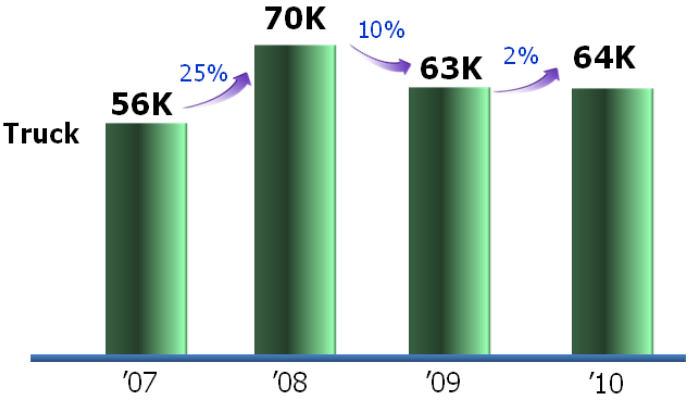
Figure 5.8 shows that although the number of delivery order got increased since 2007, actual number of trucks used for transporting was decreased sharply since the logistics integration.




**(Figure 5.8)** No of DO & shipments created

It means that the space of truck used to be wasted before the integration started being used efficiently after the logistics integration as it is managed by a logistics specialize company called 3PL or 4PL.

In addition, as EDC controls the whole order deliveries from subsidiaries over the Europe, it becomes very common to share either the cross docking terminals or hubs once customers are located on the same direction although the orders are created from a different subsidiary. See figure 5.9




**(Figure 5.9)** No of trucks used

### *5.3.7.2. Supporting example (GVC)*

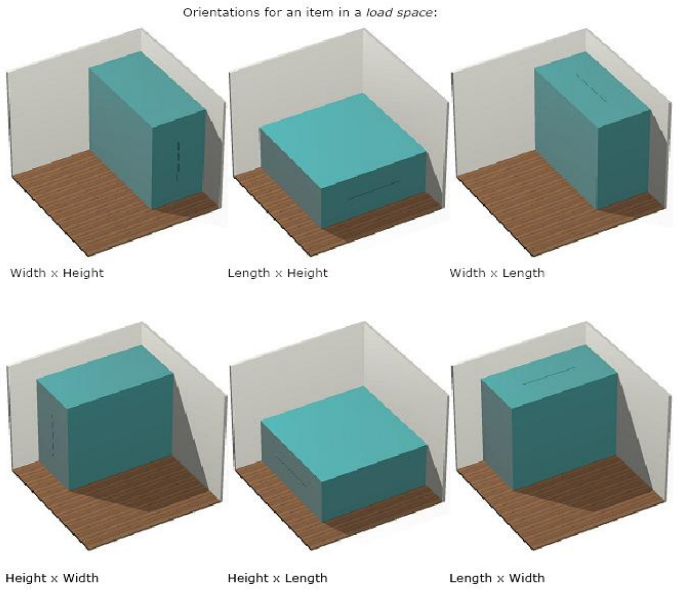
The logistics transportation cost is directly related how shipments are well

consolidated because poor consolidation would lead to a waste of container space and it will again lead to over transportation cost payment per shipment. When logistics operation is integrated in Samsung, it allowed form Samsung to implement a new ***GVC (Gross Volume Calculation)*** concept so called pre-calculated stacking patterns. The following is an overview of data collected, and also how the calculation will be done

#### *5.3.7.2.1. Master Data (Item Master data)*

In order to use the GVC concept, the integrated master data among involved parties such as Samsung itself but also with carriers had to be utilized in advance. Since 2007, the below master data has been collected, integrated and standardized.

- Material Number (product model code)
- Length / Width / Height / Weight
- Maximum per stack (Preventing damage to bottom box if needed)
- Positioning of the box on the pallet (see Figure 5-10)
- Model code visible (To specify where model code can be found, for stacking on outside of the pallet)
- Pieces per pallet (Number of material on full pallet)




**(Figure 5.10)** Positioning of a product on a pallet to maximize the consolidation rate

#### *5.3.7.2.2. Pallet Master Data*

Additionally, the pallet master data also has been integrated. Before the integration, a type of pallets handled in the Samsung EDC was more than a hundred kinds. It was an obstacle for Samsung to build a standardized pallet master data. So a number of pallet types used has been standardized under the agreement not only with customers but also carriers and DSC.

- Type of pallets
- Length / Width / Maximum Height
- Own Height / Tare Weight / Max Weight

#### *5.3.7.2.3. Calculation Data*

The standardized master data for materials and pallets made the prediction of maximum stacking Patten possible per pallet and it also allowed to figure out maximum pallet height as per ordered quantity which are essential information to forecast a number of truck accurately especially during the peak season.

- Maximum stack
- Maximum Pallet height (Truck, Customer requirement or others)
- Quantity Ordered

#### *5.3.7.2.4. Pre calculation of Stacking patterns*

In order to be able to calculate shipment totals in an acceptable time, a pre calculation table will be filled and this table will contain the maximum number of pieces for a single maternal order request. However once there are mixed material order request is made, in case GVC calculation method will be used. Pre calculation of Stacking patterns is listed up as below.

- For each material
- For each pallet type
- For each height restriction
- For each over stack
- Model Code visible (Yes/No)

The following data will be stored

- Actual Length
- Actual Width
- Actual Height
- Actual Weight
- Pieces per pallet

For example, when there are 6 different types of pallet type and one factory pallet (So a total of 7) and 9 different height restrictions (160-240) with 4 different over-stacking, this means that 7*9*4=252 calculations will be systematically stored automatically. See Figure 5-11 for an example of the data

#### *5.3.7.2.5. Possible exceptions*

Currently it is possible within SAP (Samsung internal ERP system) to select a customer requirement like for example EUR (Euro Pallet), even if the material is 150 long. When using the pre calculation, this stacking will not be allowed if it exceeds pallet length+ maximum over stack. This would mean that shipping this material is not possible on a EUR pallet. *So as a Solution, w*henever this happens, we use the 'Alternative pallet' of the material and if customer orders less than full pallet, GVC will calculate with 'Alternative Pallet'.

#### *5.3.7.2.6. Full Pallet Calculation*

Based on the Pallet Type and Height restriction for a specific material, we accessed the pre calculation info. Here we will find the quantity for the specified constraints

| Material | PalletType | Max Height | Length | Width | Height | Pieces | Weight |
|---|---|---|---|---|---|---|---|
| 123 | EUR120X080 | 160 | 120 | 84 | 150 | 50 | 75 |
| 123 | EUR120X080 | 170 | 120 | 84 | 150 | 50 | 75 |
| 123 | EUR120X080 | 180 | 120 | 84 | 175 | 60 | 90 |
| ... | | | | | | | |
| 456 | IND120X100 | 160 | 122 | 102 | 158 | 10 | 150 |
| 456 | IND120X100 | 170 | 122 | 102 | 168 | 12 | 180 |
| 456 | IND120X100 | 180 | 122 | 102 | 178 | 14 | 210 |

**(Figure 5.11)** an example of collected data

Based on this figure, we can calculate the number of 'Full' pallets (Example 123,

EUR, 160 high, order quantity 100 = 2 Pallets)

#### *5.3.7.2.7. Rest pallet Calculation*

Whenever the order quantity is not a multiple of the 'Pieces', rest pallets have to be calculated.

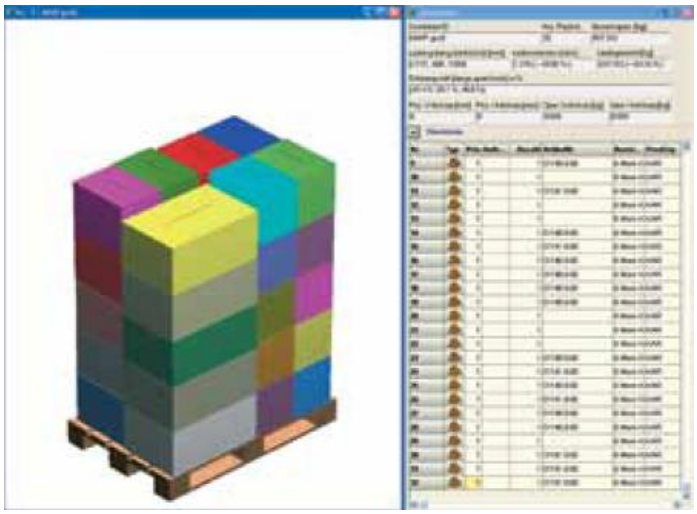
- *Determine rest pallet quantity*

  Use the 'Alternative Pallet' from the item master data. If various items have 'rest', then the calculation method of pallets will be converted from the pre-calculation method to GVC method using the stacking pattern mentioned in figure 5.10 which maximize the number of materials on a pallet

The basic concept of the calculation of consolidation rule hidden behind of the operation in Samsung has been studied so far. However the explanation of the calculation concept here is very simplified for better understanding though it is further complex in reality and not able to explain every detail in IT point of view.

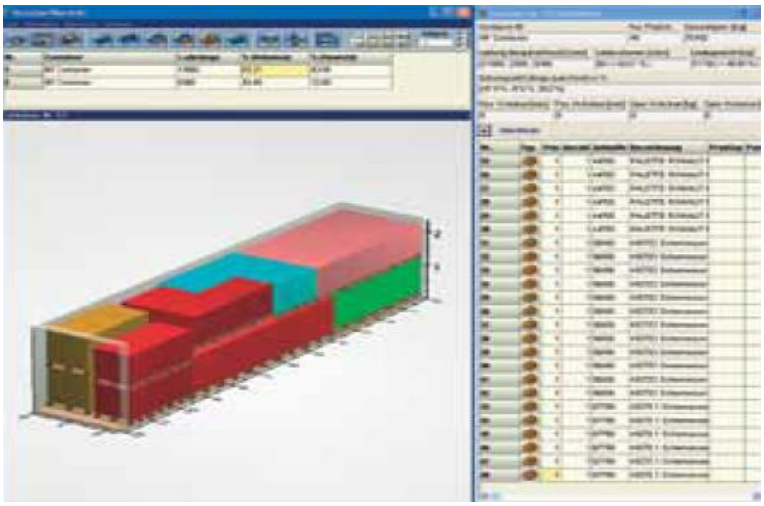
As soon as the pre-calculation for the possible consolidation is done, each screen installed in the W/H shows the instruction how to stack on a pallet. See Figure 5.12,13. It shows the instruction of stacking on pallet and each number means the sequence of stacking on pallet so that warehouse workers could follow the optimized stacking pattern calculated by system which leads to maximized palletizing.

**(Figure 5.12)** Stacking instruction by consolidation optimization



**(Figure 5.13)** Completed stacking simulated by system

Once the stacking is ready by W/H workers, these pallets will be loaded on a truck according to the sequence instructed by the implemented consolidation system. See Figure 5.14.



**(Figure 5.14)** Pallet loading instruction on truck

### *5.3.8. Q8. Demand forecast accuracy*

#### *5.3.8.1. Data Mining result*

The definition of Demand forecast accuracy is how the sales forecast is accurate compared to the actual sales. In the chapter 1, it's mentioned that one of the positive factors by the integrated logistics is the Demand Forecast Accuracy improvement.

As sales subsidiaries are able to focus on their own roles, they could get more accurate sales forecast. The more it's closed to "1(meaning 100% accuracy)", we assume that it has more accurate demand forecast.

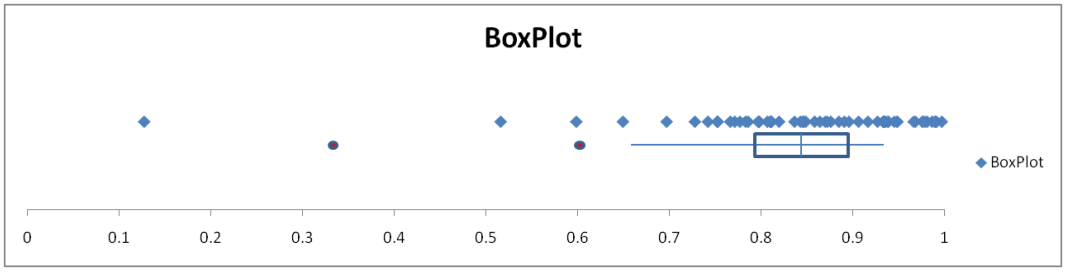
According to the t-Test, as P value (0.0109) is smaller than the significance level (0.05), there is not enough evidence to support H0 (No influence). (See Table 5.7) It means that there is enough proof to insist that there is a positive influence (H1) to the forecast accuracy by the logistics integration in Samsung EDC with 95% confidential level. Besides, the t-estimate test also shows that there is roughly 2 percent of the forecast accuracy has improved after the integration. See appendix8 (e)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.979 | 0.992 | t Stat | -2.35 |
| Variance | 0.0013 | 0.0002 | P(T<=t) one-tail | 0.0109 |
| Sample size | 50.0000 | 49.0000 | t Critical one-tail | 1.6686 |
| Degrees of freedom | 65.93 | | P(T<=t) two-tail | 0.0219 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9971 |
| Alpha | 0.05 | | | |

**(Table 5.7)** T-test of the forecast accuracy

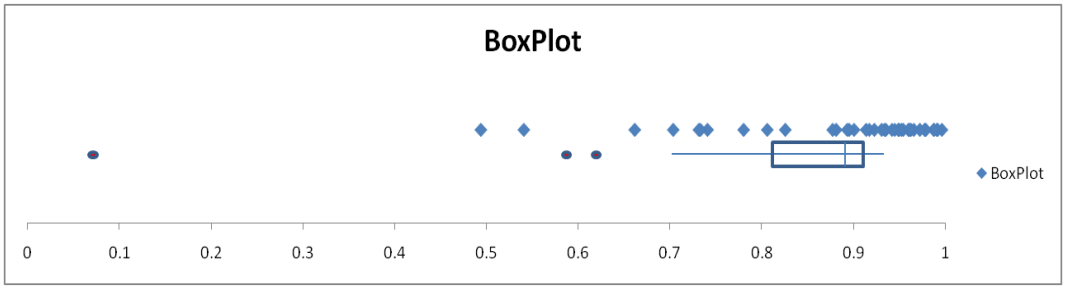
Furthermore, as it can be seen as below, the 2nd Box Plot shows that it has more accurate demand forecast as most of demand forecast accuracy date collected after the logistics integration are close to 1 (100% accuracy).

On the other hands, the 1st Box Plot's demand forecast data collected after the logistics integration are evenly spread between 0.7 and 1. As we consider that once it's closed to 1 which is 100% accuracy, it has more accurate demand forecast, we can infer that there is clear evidence that the demand forecast accuracy has been enhanced after the logistics integration.




**(Figure 5.15)** Box Plot of Demand Forecast Accuracy (before)

**(Source)** Jang, “Analysis of Logistics integration effectiveness based on Samsung model”, 2010




**(Figure 5.16)** Box Plot of Demand Forecast Accuracy (After)

**(Source)** Jang, “Analysis of Logistics integration effectiveness based on Samsung model”, 2010

## 5.4. Analysis Results summary

So far we have run statistical tests with 5% of significance level in order to puzzle the T-test outcomes with the previous literature review to verify if the results of the data mining are substantiated as the literature review which is evidence for a positive Linkage between integration and logistical performance.

The test results state that not only the Known positive factors of Logistics integration such as bad aging stock, Stock Availability, OTG, OTD, OT-IOD and Demand forecast accuracy are improved but also logistics cost saving and consolidation rate also have been enhanced. For instance, the bad aging stock rate has been roughly 0.6% to 2.4% decreased after the logistics integration.

Furthermore the hypothesis test results for the two main Key performance index (OTG, Stock availability) show that the performance has been exceptionally enhanced after the logistics integration. The test result shows that the OTG has been improved roughly 0.25 to 2.3 percent and the stock availability rate also has been improved about 0.6 percent.

Lastly we could also see that sales subsidiaries are able to forecast more accurate forecast demand after the integration as they less focus on logistics operation itself but their own roles such as marketing and sales, and forecast. In the next chapter, I will show how the logistical performance Index has been

improved with the examples adjusted in Samsung EDC's daily operation after the logistics integration. The test results like table 5.8

| *index* | *Index concepts* | *Survey results* | *Data mining* | *Supporting Example* |
|---|---|---|---|---|
| *Q1* | ***Bad Aging Stock Rate*** | Support $H_1$ | ***Bad aging stock has decreased*** | |
| *Q2* | ***Stock Availability rate*** | Support $H_1$ | ***Stock availability has increased*** | |
| *Q3* | ***On Time Good Issue Rate*** | Support $H_1$ | ***OTG rate has improved*** | ***Improved OTG due to cut off rule*** |
| *Q4* | ***On Time Delivery Rate*** | Support $H_1$ | ***OTD rate has improved*** | ***Improved OTD due to HSF and advanced delivery progress report*** |
| *Q5* | ***On Time IOD Rate*** | Support $H_1$ | ***OTI rate has improved*** | |
| *Q6* | ***Logistics Cost reduction*** | Support $H_1$ | ***Cost/CBM has been decreased*** | |
| *Q7* | ***Improvement of consolidation*** | Support $H_1$ | ***Consolidation rate has increased*** | ***Improved consolidation due to GVC*** |
| *Q8* | ***Demand forecast accuracy*** | Support $H_1$ | ***Forecast accuracy has improved*** | |
| *Q9* | ***Delivery Visibility*** | Support $H_1$ | | ***Clearer visibility due to advanced delivery progress report*** |

**Table 5.8** Analysis comparison for logistical performance index

# Chapter 6 Conclusion

## 6.1 contributions

The research is mostly about the linkage between logistics integration and logistical performance and how the logistics integration affected positively to its logistics operation within the specific Samsung EDC environment. The research has been performed by testing several statistical methods based on the survey and data mining accumulated since 2007.

The survey questions are used so as to avoid any influenced conclusion. Also several screening questions are asked in order to contain background knowledge about the survey population during the survey. However it also has some limitation as a weak point that this is an uncontrolled experiment so it was not possible to determine causal relationships, besides some categories of the population are poorly represented in the sample.

The majority of the respondents replied that the key logistical performance indexes were improved a lot by the integration and the survey results are verified again by the data mining result from the company information systems that the logistics integration has affected positively to the logistical performance indexes.

The statistical test results say that the Known positive factors of Logistics integration such as bad aging stock, Key Performance Index, and Demand forecast accuracy are improved a lot. For instance, the bad aging stock rate has been roughly 0.6% to 2.4% decreased after the logistics integration.

Besides the hypothesis test results for the two main Key performance index (OTG, Stock availability) show that the performance has been incredibly enhanced after the integration. The test result shows that the OTG has been improved roughly 0.25 to 2.3 percent and the stock availability rate also has been improved about 0.6 percent.

We also found out that sales subsidiaries was able to forecast more accurate forecast demand after the logistics integration as they less focus on logistics operation itself but on their own roles such as marketing and sales, and forecast.

The survey results out of 9 main questions from the respondents also show that the logistics integration has affected positively to the improvement of the logistical performance which is the same outcome as the analysis of the data mining results. So we can say the logistics integration within the specific Samsung EDC environment was definitely a large part of the success factor for the improvement of logistical performance in this business case.

## 6.2 Practical Implication

Although we concluded that the logistics integration has affected positively to the improvement of the logistical performance indexes in Samsung EDC, it does not guarantee any success performance improvement in other business industry as this case study is done only in customer electronics environment.

Besides the logistics integration project was gradually done for a year by a dedicated workforces and lots of monetary investment was made till its full implementation so it is still a question when the company will be able to get its investment's worth back though the performance index shows the positive outcome.

In addition, as a lot of IT modification was involved for the project, it also caused some chaos of daily operation at the beginning of the project implementation. Although lots of simulation was done before go-live, we also faced some difficulties as IT is directly connected with WMS and TMS which are the gist of daily operation in Samsung EDC. So once there is no full IT support, successful logistics integration cannot be expected.

## 6.3 Future Research

It’s been often questioned during the research how much monetary benefits will be out of each logistical performance index. As it’s mentioned before that the investment was huge but we still do not know if we reached the breakeven point though it’s been passed 4 years since the integration as it’s never been calculated in monetary point.

So if allowed, it will be a meaningful study to analyze how much cost we have

benefited from the projects. Furthermore it will be also interesting to investigate disadvantages of the integration as this research is mostly focused on the positive benefits out of the integration.

I believe that this research proved that logistics integration will be a successful factor if properly implemented but we can go further that how much the pitfall of the integration can cost so that we can eventually get a pure monetary saving from the integration as this study is mainly focused on experimental case study.

# Appendix

***Appendix 1. Bad Aging Stock Rate (≥ 60 days)***

***(Source) Jang, "Analysis of Logistics integration effectiveness based on Samsung model", 2010***

a. Data

| | | | |
|---|---|---|---|
| Sample size 1 (n) | 135 | Sample size 2 (n) | 126 |
| Sample mean 1 (before) | 0 | Sample mean 2(after) | 0 |
| Sample var 1 (before) | 0 | Sample var 2 (after) | 0 |

b. Variance Hypotheses

; To check if the variance of the 2 samples are the same or different

H0: s1/s2 = 1

H1: s1/s2 ≠ 1

c. F-Test(4.48) of the Ratio of Two Variances

; As F stat is in the range of rejection area, we can reject H0 (null hypothesis)
(Groups 1 and 2 have a different variance)

| | Sample 1 | Sample 2 | F Stat | 4.48 |
|---|---|---|---|---|
| Sample variance | 0 | 0 | P(F<=f) one-tail | 0.0000 |
| Sample size | 135 | 126 | f Critical one-tail | 1.3380 |
| Alpha | 0.05 | | P(F<=f) two-tail | 0.0000 |
| | | | f Critical two-tail | 0.7081 |
| | | | | 1.4152 |

**Table 2-1** F-test of Bad Aging Stock Rate

d. t-Test of the Difference Between Two Means (Unequal-Variances)

H0: (MU1-MU2) = 0 (No influence)

H1: (MU1-MU2) > 0 (Positively influencing)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.026 | 0.012 | t Stat | 3.22 |

| | | | | |
|---|---|---|---|---|
| Variance | 0.002 | 0.001 | P(T<=t) one-tail | 0.0007 |
| Sample size | 135 | 126 | t Critical one-tail | 1.6528 |
| Degrees of freedom | 193.84 | | P(T<=t) two-tail | 0.0015 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9723 |
| Alpha | 0.05 | | | |

**Table 2-2** T-test of Bad Aging Stock Rate

e. t-Estimate of the Difference Between Two Means (Unequal-Variances)

| | Sample 1 | Sample 2 | Confidence Interval Estimate | ± |
|---|---|---|---|---|
| Mean | 0.026 | 0.012 | 1% | 0.9% |
| Variance | 0.002 | 0.001 | Lower confidence limit | 0.6% |
| Sample size | 135 | 126 | Upper confidence limit | 2.4% |
| Degrees of freedom | 193.84 | | | |
| Confidence level | 0.95 | | | |

**Table 2-3** T-estimate of Bad Aging Stock Rate

***Appendix 2. Stock (Inventory) Availability rate***

***(Source) Jang, "Analysis of Logistics integration effectiveness based on Samsung model", 2010***

a. Data

| | | | |
|---|---|---|---|
| Sample size 1 (n) | 83 | Sample size 2 (n) | 118 |
| Sample mean 1 (before) | 0.991 | Sample mean 2 (after) | 0.994 |
| Sample var 1 (before) | 0.0001 | Sample var 2 (after) | 0.0001 |

b. Variance Hypotheses

; To check if the variance of the 2 samples are the same or different

H0: s1/s2 = 1

H1: s1/s2 ≠ 1

c. F-Test of the Ratio of Two Variances

; As F (0.57) stat is in the range of rejection area, we can reject H0 (null hypothesis)

(Groups 1 and 2 have different variances)

| | Sample 1 | Sample 2 | F Stat | 0.57 |
|---|---|---|---|---|
| Sample variance | 0.0001 | 0.0002 | P(F<=f) one-tail | 0.0041 |
| Sample size | 83 | 118 | f Critical one-tail | 1.3923 |
| Alpha | 0.05 | | P(F<=f) two-tail | 0.0082 |
| | | | f Critical two-tail | 0.6644 |
| | | | | 1.4836 |

**Table 2-4** F-test of stock availability

d. t-Test of the Difference Between Two Means (Unequal-Variances)

H0: (MU1-MU2) = 0 (No influence)

H1: (MU1-MU2) < 0 (Positively influencing)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.991 | 0.994 | t Stat | -1.96 |
| Variance | 0.000 | 0.000 | P(T<=t) one-tail | 0.0259 |
| Sample size | 83 | 118 | t Critical one-tail | 1.6526 |
| Degrees of freedom | 197.86 | | P(T<=t) two-tail | 0.0518 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9721 |
| Alpha | 0.05 | | | |

**Table 2-5** T-test of stock availability

e. t-Estimate of the Difference Between Two Means (Unequal-Variances)

| | Sample 1 | Sample 2 | Confidence Interval Estimate | ± |
|---|---|---|---|---|
| Mean | 0.991 | 0.994 | -0.3% | 0.3% |
| Variance | 0.000 | 0.000 | Lower confidence limit | -0.6% |
| Sample size | 83 | 118 | Upper confidence limit | 0.0% |
| Degrees of freedom | 197.86 | | | |
| Confidence level | 0.95 | | | |

**Table 2-6** T-estimate of stock availability

***Appendix 3. OTG Rate (<=1)***

***(Source) Jang, "Analysis of Logistics integration effectiveness based on Samsung model", 2010***

a. Data

| | | | |
|---|---|---|---|
| Sample size 1 (n) | 83 | Sample size 2 (n) | 118 |
| Sample mean 1 (before) | 0.986 | Sample mean 2 (after) | 0.999 |
| Sample var 1 (before) | 0.002 | Sample var 2 (after) | 0.000 |

b. Variance Hypotheses

; To check if the variance of the 2 samples are the same or different

H0: s1/s2 = 1, H1: s1/s2 ≠ 1

c. F-Test of the Ratio of Two Variances

| | | | | |
|---|---|---|---|---|
| | Sample 1 | Sample 2 | F Stat | 279.28 |
| Sample variance | 0.0021 | 0.0000 | P(F<=f) one-tail | 0.0000 |
| Sample size | 83 | 128 | f Critical one-tail | 1.3831 |
| Alpha | 0.05 | | P(F<=f) two-tail | 0.0000 |
| | | | f Critical two-tail | 0.6680 |
| | | | | 1.4718 |

**Table 2-7** F-test of on time good issue

d. t-Test of the Difference Between Two Means (Unequal-Variances)

H0: (MU1-MU2) = 0 (No influence)

H1: (MU1-MU2) < 0 (Positively influencing)

| | | | | |
|---|---|---|---|---|
| | Sample 1 | Sample 2 | | |
| Mean | 0.986 | 0.999 | t Stat | -2.49 |

| | | | | |
|---|---|---|---|---|
| Variance | 0.002 | 0.000 | P(T<=t) one-tail | 0.0074 |
| Sample size | 83 | 128 | t Critical one-tail | 1.6636 |
| Degrees of freedom | 82.38 | | P(T<=t) two-tail | 0.0149 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9893 |
| Alpha | 0.05 | | | |

**Table 2-8** T-test of on time good issue

e. t-Estimate of the Difference Between Two Means (Unequal-Variances)

| | Sample 1 | Sample 2 | Confidence Interval Estimate | ± |
|---|---|---|---|---|
| Mean | 0.986 | 0.999 | -1.3% | 1.0% |
| Variance | 0.002 | 0.000 | Lower confidence limit | -2.3% |
| Sample size | 83 | 128 | Upper confidence limit | -0.25% |
| Degrees of freedom | 82.38 | | | |
| Confidence level | 0.95 | | | |

**Table 2-9** T-estimate of on time good issue

***Appendix 4. Performance Metrics***

| Performance Metrics | Definition |
|---|---|
| ANS | ● The ability to notify customers in advance of delivery when products will arrive |
| Customer Satisfaction | ● The global judgment regarding the extent to which perceived logistics performance matches customer expectations |
| Delivery Depend ability | ● The ability to meet quoted or anticipated delivery dates and quantities on a consistent basis |
| Delivery Speed | ● The ability to reduce the time between order receipt and customer delivery to as close to zero as possible |
| Delivery Time Flexibility | ● The ability to accommodate delivery times for specific customers |
| Inventory Turns | ● The ratio of cost of goods sold divided by the average investment in inventory during a time period |
| Information Systems Support | ● The ability of information systems to provide operational managers with sufficient and timely |

| | |
|---|---|
| | information to manage logistical activities |
| Low Logistics Cost | ● The ability to achieve the lowest total cost of logistics through efficient operations, technology, and/or scale economies |
| Order Fill Capacity | ● The ability to provide desired quantities on a consistent basis |
| Order Flexibility | ● The ability to modify order size, volume, or composition during logistics operation |
| Product Flexibility(Customization) | ● The ability to handle difficult, nonstandard orders to meet special customer specifications and to manufacture products characterized by numerous features, options, size, and/or colors |
| Responsiveness to Key Customers | ● The ability to respond to the needs and wants of key customers |
| Return on Assets(ROA) | ● The ratio of income before interest expense divided by average total assets |

**Source**: Performance Benefits of Supply Chain Logistical Integration, 2005, Performance Metrics (p15)

***Appendix 5. On Time Delivery Rate***

a. Data

| | | | |
|---|---|---|---|
| Sample size 1 (n) | 60 | Sample size 2 (n) | 60 |
| Sample mean 1 (before) | 0.990 | Sample mean 2 (after) | 0.993 |
| Sample var 1 (before) | 0.0001 | Sample var 2 (after) | 0.0002 |

b. Variance Hypotheses

; To check if the variance of the 2 samples are the same or different

H0: s1/s2 = 1, H1: s1/s2 ≠ 1

c. F-Test of the Ratio of Two Variances

| | Sample 1 | Sample 2 | F Stat | 0.35 |
|---|---|---|---|---|
| Sample variance | 0.0001 | 0.0002 | P(F<=f) one-tail | 0.0000 |
| Sample size | 60 | 60 | f Critical one-tail | 1.5400 |

| | | | | |
|---|---|---|---|---|
| Alpha | 0.05 | | P(F<=f) two-tail | 0.0001 |
| | | | f Critical two-tail | 0.5973 |
| | | | | 1.6741 |

**Table 2-10** F-test of on time delivery

d. t-Test of the Difference Between Two Means (Unequal-Variances)

H0: (MU1-MU2) = 0 (No influence)
H1: (MU1-MU2) < 0 (Positively influencing)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.990 | 0.993 | t Stat | -1.72 |
| Variance | 0.0001 | 0.0002 | P(T<=t) one-tail | 0.0444 |
| Sample size | 60.0000 | 60.0000 | t Critical one-tail | 1.6611 |
| Degrees of freedom | 95.53 | | P(T<=t) two-tail | 0.0888 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9853 |
| Alpha | 0.05 | | | |

**Table 2-11** T-test of on time delivery

e. t-Estimate of the Difference Between Two Means (Unequal-Variances)

| | Sample 1 | Sample 2 | Confidence Interval Estimate | |
|---|---|---|---|---|
| Mean | 0.99 | 0.99 | 0.00 | ± |
| Variance | 0.00 | 0.00 | Lower confidence limit | -0.01 |
| Sample size | 60.00 | 60.00 | Upper confidence limit | 0.00 |
| Degrees of freedom | 95.53 | | | |
| Confidence level | 0.95 | | | |

**Table 2-12** T-estimate of on time delivery

***Appendix6. Cost reduction per cubic meter***

a. Data

| | | | |
|---|---|---|---|
| Sample size 1 (n) | 12 | Sample size 2 (n) | 18 |
| Sample mean 1 (before) | 68.005 | Sample mean 2 (after) | 58.256 |

| | | | |
|---|---|---|---|
| Sample var 1 (before) | 53.7284 | Sample var 2 (after) | 32.6039 |

b. Variance Hypotheses

; To check if the variance of the 2 samples are the same or different

H0: s1/s2 = 1, H1: s1/s2 ≠ 1

c. F-Test of the Ratio of Two Variances

| | Sample 1 | Sample 2 | F Stat | 1.65 |
|---|---|---|---|---|
| Sample variance | 53.7284 | 32.6039 | P(F<=f) one-tail | 0.1717 |
| Sample size | 12 | 18 | f Critical one-tail | 2.4126 |
| Alpha | 0.05 | | P(F<=f) two-tail | 0.3435 |
| | | | f Critical two-tail | 0.3047 |
| | | | | 2.8696 |

**Table 2-13** F-test of the cost reduction

d. t-Test of the Difference Between Two Means (Unequal-Variances)

H0: (MU1-MU2) = 0 (No influence)

H1: (MU1-MU2) < 0 (Positively influencing)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 68.005 | 58.256 | t Stat | 3.89 |
| Variance | 53.7284 | 32.6039 | P(T<=t) one-tail | 0.0005 |
| Sample size | 12.0000 | 18.0000 | t Critical one-tail | 1.7291 |
| Degrees of freedom | 19.62 | | P(T<=t) two-tail | 0.0010 |
| Hypothesized difference | 0 | | t Critical two-tail | 2.0930 |
| Alpha | 0.05 | | | |

**Table 2-14** T-test of the cost reduction

e. t-Estimate of the Difference Between Two Means (Unequal-Variances)

| | Sample 1 | Sample 2 | Confidence Interval Estimate | |
|---|---|---|---|---|
| Mean | 68.01 | 58.26 | 9.75 | ± |
| Variance | 53.73 | 32.60 | Lower confidence limit | 4.50 |
| Sample size | 12.00 | 18.00 | Upper confidence limit | 15.00 |

| | | | | |
|---|---|---|---|---|
| Degrees of freedom | 19.62 | | | |
| Confidence level | 0.95 | | | |

**Table 2-15** T-estimate of the cost reduction

***Appendix7.On Time IOD rate***

a. Data

| | | | |
|---|---|---|---|
| Sample size 1 (n) | 50 | Sample size 2 (n) | 49 |
| Sample mean 1 (before) | 0.979 | Sample mean 2 (after) | 0.992 |
| Sample var 1 (before) | 0.0013 | Sample var 2 (after) | 0.0002 |

b. Variance Hypotheses

; To check if the variance of the 2 samples are the same or different

H0: s1/s2 = 1, H1: s1/s2 ≠ 1

c. F-Test of the Ratio of Two Variances

| | Sample 1 | Sample 2 | F Stat | 5.71 |
|---|---|---|---|---|
| Sample variance | 0.0013 | 0.0002 | P(F<=f) one-tail | 0.0000 |
| Sample size | 50.0000 | 49.0000 | f Critical one-tail | 1.6124 |
| Alpha | 0.05 | | P(F<=f) two-tail | 0.0000 |
| | | | f Critical two-tail | 0.5662 |
| | | | | 1.7690 |

**Table 2-13** F-test of the on time IOD

d. t-Test of the Difference Between Two Means (Unequal-Variances)

H0: (MU1-MU2) = 0 (No influence)

H1: (MU1-MU2) < 0 (Positively influencing)

| | Sample 1 | Sample 2 | | |
|---|---|---|---|---|
| Mean | 0.979 | 0.992 | t Stat | -2.35 |
| Variance | 0.0013 | 0.0002 | P(T<=t) one-tail | 0.0109 |

| | | | | |
|---|---|---|---|---|
| Sample size | 50.0000 | 49.0000 | t Critical one-tail | 1.6686 |
| Degrees of freedom | 65.93 | | P(T<=t) two-tail | 0.0219 |
| Hypothesized difference | 0 | | t Critical two-tail | 1.9971 |
| Alpha | 0.05 | | | |

**Table 2-14** T-test of the on time IOD

e. t-Estimate of the Difference Between Two Means (Unequal-Variances)

| | Sample 1 | Sample 2 | Confidence Interval Estimate | |
|---|---|---|---|---|
| Mean | 0.98 | 0.99 | -0.01 | ± |
| Variance | 0.00 | 0.00 | Lower confidence limit | -0.02 |
| Sample size | 50.00 | 49.00 | Upper confidence limit | 0.00 |
| Degrees of freedom | 65.93 | | | |
| Confidence level | 0.95 | | | |

**Table 2-15** T-estimate of the on time IOD

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# Survey Questions

## Analysis of Logistics integration effectiveness

## 1. Research questions (13 questions)

Dear Sir/madam

This mail is from Samsung EEDC which provides Logistic service to you.
I would like to have some feedback for logistics integration in Eastern Europe Distribution Center (EEDC). The logistics integration has been completed for several sales subs since July 2007 and a main changing factor of the integration was to improve logistical performance index. Considering this factor, please answer the questions regarding the Changes based on your thought.

Your answer will be used only for research purpose with confidential (anonymous).
After taking into consideration the status before and after to the logistics integration (since 2007), please mark your points about the effects of the integration.

-3 (strongest negative) to 3 (strongest Positive) as well as 0 (negligible changes)

1. How do you think the logistics integration in EEDC influence the Bad Aging Stock rate decrease in the warehouse?

◉ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

2. How do you think the logistics integration in EEDC influence the Stock Availability improvement?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

3. How do you think the logistics integration in EEDC influence the improvement of performance such as on Time good issue Rate?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

4. How do you think the logistics integration in EEDC influence the improvement of performance such as on Time Delivery Rate?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

5. How do you think the logistics integration in EEDC influence the improvement of performance such as On Time IOD Rate?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

6. How do you think the logistics integration in EEDC influence the improvement of performance such as Logistics Cost reduction (Logistics Cost per CBM)?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

7. How do you think the logistics integration in EEDC influence the improvement of shipment consolidation?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

8. How do you think the logistics integration in EEDC influence the logistical performance such as Demand forecast accuracy?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

9. How do you think the logistics integration in EEDC influence the logistical performance such as Advance Delivery Visibility improvement?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

10. How do you think the logistics integration get the benefit of Logistics Cost due to economy of scale and scope?

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3

**2. Personal Information**

Please reflect your information to answer these questions

14. What is your company type?

○ Supplier(Carriers)

○ SAMSUNG(EEDC)

○ DSC(Warehouse operator)

- SAMSUNG(Sales Subsidiary)
- Customers(consignee)

15. What is your job function?

- Operations
- Finance
- IT(Innovation)
- Planning(Strategy)
- Management

16. How long have you been working in EEDC?

- below 6 months
- below 1 year
- below 2 years
- below 3 years
- over 4 years

17. What do you think about the meaningful triggering changes by the logistics integration?

- (•) Internal Integration
- Material/Service Supplier Integration
- Technology and Planning Integration

- Measurement Integration
- Relationship Integration
- Other (please specify)