RFID Facilitating Strategy Using Taiwan’s Distribution Center as an Example

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Abstract—The applications of RFID are the most promising issue which have caught attentions from every aspects of the global supply chain members. Both Wal-Mart and the Department of Defense, USA have announced that they will be facilitating RFID technology as their mainly strategy of supply chain management. Top suppliers are asked to furnish the utilization of this emerging technology. The goal has been set up to catch the potential benefits of RFID which including enhanced products visibility, traceability and safety at the manufacturing and distribution stages even throughout the total lifecycle. More and more fields take aggressive steps on RFID adoption and some business cases have revealed the advantage of RFID technology.

As an important manufacturing and distribution base on the world, Taiwan has noticed this trend. In order to promote the competitiveness and to link up with the world through the application of RFID, this research focus on the facilitating strategy that how a Taiwan’s business implement a new technology. We take distribution centers as our observe target, the collaborate module of government and enterprise will also be discussed.

Index Terms—Radio Frequency Identification (RFID), Distribution Center (DC)

I. INTRODUCTION

RFID identification system is mainly and jointly composed of Tag, Antenna, Controller, Middleware, and Database [1,2]. Signal is delivered by IC within Tag that is not larger than 2 centimeter squares through Reader to the electromagnetic circuit power supply within IC Drive. Then Antenna transmits the information stored inside the memory to controller and via Middleware encoding, ID Code is finally corresponding to adequate Database and is shown in Tag Identification System which characters that are human identifiable, such as shown in Figure 1— that is the construction figure of RFID. It also has the same contactless R/W properties as smart card and IC card, which can be used to replace the existing fixed or contact identification Tag [4]. And at the same time, it can read many data [2] and have better R/W ability and larger data storage space than Bar code.

In conception, besides hardware system, RFID should further include the corresponding software, and integrate the supply chain of enterprise both internally and externally. Figure 2 displays the complete framework of RFID system, which should include Tags, Readers, Integration, and Processing [5]. In Tag stage, to determine hardware specifications, we should depend on the environment estimation and analysis in advance, and then after the Tag is decided, the performance of reader & writer should be considered in designing the optimal position.

Figure 1. RFID composition Figure (Picture sources: Center For Aerospace and Systems Technology, ITRI)

Figure 2. Framework of RFID system

And the network system, which connects reader & writer to database through wired or wireless method, analyzes the data through the accounting or tool software of stock logistics that is installed in the system beforehand, and stores it and produces it into each report for the analysis reference of decision maker.
However, RFID presently faces the largest bottleneck, that is, the specifications is failed to standardize. At present, two large organizations, namely EPCglobal of England and United States system, and Ubiquitous ID Center (UID) of Japan system have the most influence in the aspect of specifications promotion [4]. Recently, the UHF Generation 2 that is developed by more than 60 first technology companies of the world integrates RFID technology, and network through EPC network to provide the accurate information that conforms to cost-benefit in the supply chain. The so-called GEN2 standard is the basic element of EPCglobal network. In the future, they will look for the approval of International Organization for Standardization and it will be compatible and collateral with the announced EPC standard, such as Class1, Class2, or even ISO 18000-6A and 18000-6B to provide a safer and faster open standard [2].

II. THE REFORMATION OF SUPPLY CHAIN

In the past, supply chain is connected linearly. Most use mails, facsimiles or telephone method to pass on information through vertical integration, and with the Internet development and the computerization of supply chain, it gradually develops into collaborative nonlinear supply chain. But in the future, market will be heading to demand-driven production method, such as shown in figure 3. Large reformation of market mechanism will also affect the production, marketing, and the stock strategy of enterprise; therefore, enterprises should conform to the supply chain form of the future, which is demand-driven. RFID is exactly the basic technology that accomplishes demand-driven supply chain form.

Fig 3. RFID development in promoting commercial mode

A. RFID will reconstruct the supply chain form

To satisfy the rapidly changing customers’ demand, supply chain structure is also changing rapidly. Along with the growth of information in the whole world, enterprises should response to customers’ demand with faster mechanism, and hence, enterprise flow path should be reconstructed. And in this process, RFID plays an important role, because the real-time of RFID and rich information can exactly conform to the rapid changes of demand, and at the same time, RFID makes supply chain be more observable and also let customers’ demand be predictable. Therefore, we should depend on RFID technology to reach the supply chain that is mainly demand-driven. At present, RFID application is still in S&S (Slap & Ship) stage. Although it does not affect the operation method of present stage and peripheral cost does not increase due to the impact brought by RFID facilitating, the future demand-driven market is not really bearable to the present supply chain.

To be capable of producing many more yield and various production, the supply chain of future still need shorter time to reach and deliver the commodities with better quality. So besides enterprises’ flow path reconstruction, Middleware is still needed to integrate electronic commercial affairs system, and the ERP and SCM system that is extensively applied these days should be integrated into the Middleware of RFID. The achievement and time demand of the abovementioned RFID characteristics can further predict the market in order to reduce the increasing cost and stock loss of enterprises due to the bullwhip effect of supply chain. These can only be achieved through the reintegration of RFID and enterprises electronic system.

B. Common problems of RFID facilitating into industries of Taiwan

At present, Taiwan industries often encounter some unconquerable problems in RFID facilitating, such as technology feasibility, hardware cost is excessively high, the estimation method of Return On Investment (ROI), the application of successful case, difficulties in facilitating cost estimation, deficiency of complete solution plan, the flow path facilitating method developing from S&S to internal part, and etc. Among which, ROI is one of the most important indexes for enterprises in executing investment evaluation, and today, since software is still in the developing stage, the cost is still inestimable. And due to the difference in application range, the specifications of RFID Tag are not completely the same and also, the cost increment caused by flow path reconstruction of Middleware and enterprises is beyond compute, so enterprises choose the wait-and-see attitude for the most part when RFID is introduced. ROI is often adopted by enterprises to be the reference index that judges whether to invest equipment or introduce new system. Author’s individual viewpoint for ROI is that considering only the increasing benefit of RFID characteristic may neglect the ROI rough estimation value predicted by fixed cost. Here, we make the deduction and estimation as follows:

a. RFID can read many Tags at one time, so reading time \(T_{RFID} < T_{Bar code}\)

b. Real-time of RFID increases the visibility of supply chain, so inventory water line \(I_{RFID} < I_{Bar code}\)

The average profit growth rate of enterprise in the next n years:

\[
E_{RFID} = (1 + E_{RFID})^n - 1 > E_{Bar code} = (1 + E_{Bar code})^n - 1
\]

Return On Investment: (PER is Price-Earnings Ratio of enterprise)

\[
ROI_{RFID} = (1 + E_{RFID}) \times n \div PER > ROI_{Bar code} = (1 + E_{Bar code}) \times n \div PER
\]

From the abovementioned simulated calculation result, we can deduce that Return On Investment of RFID will far exceed the ROI of Bar Code with the application time of n years.
The collection of phase target and achievements of individually counseled company

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Name of project</th>
<th>Plan range/purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo Services Corp.</td>
<td>RFID application plan in Logistics</td>
<td>1. Read the Tag application plan on goods</td>
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<tr>
<td></td>
<td></td>
<td>2. The application plan of active Tag</td>
</tr>
<tr>
<td>Horng Woei Electronic Co., Ltd.</td>
<td>Feasibility evaluation and planning of UHF Tag safe control application inserted in tire</td>
<td>1. Design and develop RFID Tag inserted in tire</td>
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<td></td>
<td>2. The test of each condition (temperature, pressure, material, and etc)</td>
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<tr>
<td>Silk road Taiwan Inc.</td>
<td>Feasibility evaluation of Savant middleware establishment in RFID handheld device</td>
<td>1. The study of PML &amp; ONS</td>
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<tr>
<td></td>
<td></td>
<td>2. The study of handheld device</td>
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<tr>
<td></td>
<td></td>
<td>3. Savant test production</td>
</tr>
<tr>
<td>Goldsun Express &amp; Logistics Co., Ltd.</td>
<td>Feasibility evaluation and planning of RFID application in the third party logistics service</td>
<td>1. RFID management condition in medicine industry supply chain</td>
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<td>2. The key point of RFID in logistics operation management.</td>
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<td>KHS Audio Co., Ltd.</td>
<td>RFID application in USA market and sale passageway of KHS Audio Co. Ltd, Jupiter Wind Instrument</td>
<td>1. Tag condition</td>
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<td>2. Environment test</td>
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<tr>
<td></td>
<td></td>
<td>3. Tag evaluation</td>
</tr>
<tr>
<td></td>
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<td>4. Reader collocation</td>
</tr>
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<td>Chiao Tai Logistics Corp.</td>
<td>Feasibility evaluation and planning of RFID integration application in 3PL supply chain</td>
<td>Feasibility evaluation and planning of RFID integration application in 3PL supply chain</td>
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<td>Tai Sun Trade</td>
<td>Feasibility evaluation and planning of RFID application in professional cleansing industry</td>
<td>1. Accomplish RFID environmental plan</td>
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<td></td>
<td></td>
<td>2. Accomplish the analysis document demanded by applied software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Learn about Tag &amp; Reader function and installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. System integration result</td>
</tr>
<tr>
<td>Retail Support International</td>
<td>RFID Pilot Field Test in President Chain Store Corp. system</td>
<td>1. Assist logistics center to control logistics box and pallet stock quantity by means of RFID that is installed on logistics carrier container (logistics box, pallet)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Besides reducing the error risk occurrence in goods delivery, it can also well manage the goods.</td>
</tr>
<tr>
<td>Panda International transportation Co., Ltd.</td>
<td>RFID pilot logistics tracing test</td>
<td>1. Automatically report back the set off and reaching time.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Compile and analyze the statistics of transportation schedule.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Exception management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Reduce man-made mistake</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Warehousing management</td>
</tr>
</tbody>
</table>

III. THE RELATED FACILITATING EXPERIENCE OF TAIWAN INDUSTRY INFORMATION

A. Strategy Framework of enterprise in facilitating ERP

In the early stages, industrial competition compelled enterprises to face a very big existence threat and forced all enterprise set competitiveness improvement as their target and for the middle-sized and large-sized enterprises with more than hundreds of employees, the facilitating of ERP system not only can integrate enterprise resources but also rapidly response to customer’s demand changes. The strategy framework of enterprises when facilitating ERP can be divided into three large phases, namely diagnosis, design and facilitating.

And regarding facilitating flow path, it also can be subdivided into 5 steps, which are project preparation, business blueprint, realization, final preparation, go live & support respectively [3], such as shown in Figure 4. When enterprises facilitating ERP, its process is extremely similar to RFID facilitating condition of nowadays, and also faces the related problems concerning the supply chain integration of enterprise both internally and externally, which will be discussed in next section.

B. The problems faced by enterprises in facilitating ERP

In B2B E-Commerce application, the role that should be played by government and promoter is nothing more than the construction of trade environment, laws and regulations and establishment of trade standard. Therefore, government should construct a good network application environment to remove the existing obstacle, restrain in industry, and accelerate the revision of existing relevant laws and regulations, and establish new laws and decrees, intensify the domestic core enterprise counseling to secure commercial opportunities, and integrate resources in order to strengthen promotion achievements. And the problems that are often encountered by enterprises in facilitating ERP are as follows:

1. Fail to build good network application environment.
2. Deficiency of perfect laws and regulations of E-Commerce.
3. Middle-sized and small-sized enterprises still need to be subsidized and strengthened in education promotion.
4. Counseling should be aimed at industry, not specific enterprise.
5. Unsatisfactory integration in each promotion plan and unit resources.
6. Deficiency of professional information talents.
Project Preparation:
Enterprise and counseling manufacturer form trans-sectoral

Promote industry application:
Provide assistance in changing enterprise flow path.

Realization:
Project team gradually introduces ERP system

Final Preparation:
Optimal system to let employees actually simulate

Go live & Support:
ERP system formally starts on line operation

Figure 4. ERP Facilitating Procedures

In the abovementioned problems, the problems of item 3 and 6 are very similar to the problem encountered during RFID facilitating of present stage. Since the RFID of present stage is in pilot run stage, it still cannot provide effective exemplar construction to enterprise for reference, so most enterprises do not know the beneficial result of its facilitating, not to mention the related flow path disposition. And the authorities should also enhance the related study case with schools to increase the academic organization control and research of new technology and train up related professional talents to engage in the industry. Besides, the related technology seminar or workshop should extensively invite industry circle, authorities, and academic circle to jointly discuss it, and publish the result in responsible unit and provide window for enterprise consultation, and start improving environment (infrastructure) and related laws and regulations.

IV. CASE ANALYSIS-A CASE STUDY OF RETAIL SUPPORT INTERNATIONAL

In 1979, President Chain Store Corp. established “Logistics Session”, and in September 25th, 1990, the “Logistics Session” of the marketing department of President Chain Store Corp. was separated out, and four companies, namely Uni-President, President Chain Store Corp. and Mitsubishi Corp. of Japan, Ryosyoku Ltd. jointly put up capital to establish “Retail Support International”, which is responsible for commodities logistics delivery business of more than 2300 shop fronts of President Chain Store Corp., PRESIDENT’S BAKERY, Cosmed and etc.

In 2004, Retail Support International was guided and counseled by MOEA of Ministry of Economic Affairs to lead the way in facilitating RFID to be hardware test (P1) and in 2005, they start to introduce the test of software and hardware system (P2). The future plan is to actually execute it to the internal of enterprise and construct RFID system exemplar after each department operates normally.

A. Case Discussion: Retail Support International

The target of RFID pilot field test project of President Chain Store Corp. system is to assist logistics center to control logistics box and pallet stock quantity by means of RFID that is installed on logistics carrier container (logistics box, pallet). Besides reducing the error occurrence risk in goods delivery, it can also well manage the goods. Table 2 is the reading rate of pallet RFID at Retail Support International Center, table 3 is the reading rate

Table 2. Pallet reading rate

<table>
<thead>
<tr>
<th>Date</th>
<th>Pallet number</th>
<th>Tag read by Chungli DC</th>
<th>Tag read by Sanshia DC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Logistics boxes reading rate at logistics center

<table>
<thead>
<tr>
<th>Date</th>
<th>Chungli stock amount</th>
<th>Amount Read</th>
<th>Reading rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 12</td>
<td>1351</td>
<td>1063</td>
<td>78.68%</td>
</tr>
<tr>
<td>Oct. 13</td>
<td>360</td>
<td>292</td>
<td>81.11%</td>
</tr>
<tr>
<td>Oct. 15</td>
<td>1317</td>
<td>1050</td>
<td>79.73%</td>
</tr>
<tr>
<td>Oct. 15</td>
<td>1011</td>
<td>858</td>
<td>84.87%</td>
</tr>
<tr>
<td>Oct. 15</td>
<td>779</td>
<td>851</td>
<td>109.24%</td>
</tr>
<tr>
<td>Oct. 18</td>
<td>1146</td>
<td>909</td>
<td>79.32%</td>
</tr>
<tr>
<td>Oct. 18</td>
<td>828</td>
<td>768</td>
<td>92.75%</td>
</tr>
<tr>
<td>Oct. 20</td>
<td>959</td>
<td>840</td>
<td>87.59%</td>
</tr>
<tr>
<td>Oct. 20</td>
<td>720</td>
<td>629</td>
<td>87.36%</td>
</tr>
<tr>
<td>Total</td>
<td>8471</td>
<td>7260</td>
<td>83.93%</td>
</tr>
</tbody>
</table>

Table 4. RFID reading rate of Chungli Ji-Li Store of President Chain Store Corp. (7/11)

<table>
<thead>
<tr>
<th>Date</th>
<th>Actual logistics stock amount</th>
<th>Amount read at shop front</th>
<th>Reading rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 12</td>
<td>3</td>
<td>3</td>
<td>100%</td>
</tr>
<tr>
<td>Oct 13</td>
<td>6</td>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>9</td>
<td>100%</td>
</tr>
</tbody>
</table>
rate would be discussed in the next section.

B. Generalization of Test Problem and Suggestion

1. Bad reading rate
Since test stage adopts manpower trolley to haul pallet, the condition of each reading is not exactly the same that causes unobvious reading effect. If it is changed into unmanned trolley hauling, each reading condition can be fixed [5,6] and further promote reading rate.

2. Tag repeated reading
Increasing the reading distance between Reader and Tag is no doubt contributive to the promotion of reading rate, but it also cause material and Tag that has not passed through Reader is read into system and cause system disorder easily. If the Tag is written into mark by Reader & Writer [4], or identifying the Tag read in Middleware and do not record the Tag with the same ID in the first record will avoid the repeated reading.

3. Reading Metal and Liquid Type Content
At present, RFID Tag is also subjected to the interference of metal and liquid, which cause identification cannot be correctly executed. Increasing the distance between Tag and logistics can no doubt reduce interference, but it also reduces the volume of logistics box and results in the increment of delivery cost. If insulation object (preventing signal interference) is loaded in the wall of logistics box, it can avoid the problem of metal and liquid interference [5,6].

4. Reading Condition
For goods piling on pallet, we adopt (width) 3 boxes * (depth) 3 boxes * (height) 4 boxes method, because in the past, they adopt Barcode reading Tag to execute warehouse management, piling height is too high and causes the Tag of goods within central area cannot be read easily. If (width) 3 boxes * (depth) 3 boxes * (height) 2 boxes piling method is adopted, the tag at central area can be effectively read, and besides, Reader can also be lodged in the upper part of Inspection Gate and floor to increase reading rate.

5. Suggested Items
Making comprehensive survey of the abovementioned reading problem, if carrier or logistics box reserved for RFID use is used, it can overcome the problem of bad reading rate easily. Besides, it should be matched with exclusive RFID reading area and connect to Database through Middleware. This complete set of measures can promote the whole effect of RFID, not only focusing on the reading accuracy with S&S method. Reading accuracy will be improved after technology is promoted, and the related whole set of integration introduced should all be tested in advance to obtain more objective information during facilitating to be the policy decision reference of facilitating in the future.

V. COMPREHENSIVE SURVEY OF RFID FACILITATING STRATEGY

In November 2003, Wal-Mart formally announced to start facilitating RFID technology to manage and control the incoming and outgoing daily commodities in its logistics center. At the same time, it also requests its supplier to comprehensively use RFID since 2006 [3] which gradually makes related enterprises in the whole world face squarely to this application. This chain effect also facilitates each international or domestic large enterprise to forestall the facilitating of this technology in order to maintain or get ahead of its competitors. The success of the facilitating effect should be decided by the adequate facilitating strategy. This section will also compare the global strategy with the strategy developed in Taiwan.

A. The strategy of Taiwan Ministry of Economy Affairs.
To strengthen the international competitiveness of Taiwan enterprises, MOEA of Ministry of Economic Affairs especially cooperates with ITRI in “Industrial RFID Application Counseling Plan [2]”. The system center of ITRI is responsible for the coordination, operation and preparation affairs.

Besides technology facilitating, ITRI is also responsible to make a collective report of the progress to MOEA of Ministry of Economic Affairs, and holds nonscheduled achievements publication to be the reference for industries. And Institute for Information Industry is responsible for Middleware operation, and integrate the electronic platform of enterprise such as ERP with RFID, and stores the information read by RFID in ONS of network by using EPC encoding method through PML, which enables the server of enterprise to read ID information and further achieve globalization target. International R&D unit further publishes new technology and standard, and ITRI has the new information in hand at any time and provides the new technology to domestic semiconductor industries and information industries, while the enterprises use the new technology to develop the software and hardware with more competitive advantages.

When Ministry of Economic Affairs develops facilitating strategy, it can be divided into four stages, where the main purpose of P1 Field test is to test the hardware reliability, in another word, that is to test the read rate of Tag. Besides viewing the Tag, it also tests the impact of reading angle or position of Reader on reading rate. And the target of P2 Evaluation Test is to test the middleware.

The main purpose of this stage is to connect the database with Reader, to test the problems resulted from actual operation and improves them to enable enterprises to actually obtain the complete information of RFID Tag from database. In addition, P3 is Pilot Run stage. Besides integrating RFID Tag system, the authorized unit should further integrate E-Commerce system and supply chain management system to reach the anticipated effect of whole integration. The last is P4 Exemplified system construction stage to construct standard prototype, and the result is provided to be the reference for enterprises during facilitating RFID and provides the consultation service of related technology.

B. The RFID facilitating strategy of IBM.
Besides government guidance and counseling, International industry also actively participates in the study and plan of strategy facilitating in facilitating RFID to enterprises, where many industries provide a series of solution program. Besides developing a series of hardware technology, the related necessary middleware also tends to the integration of enterprise platform and supply chain, and even relevant enterprise that introduces
ERP also submits enterprise solution program in succession.

At first, they should carry out the lowest demand of case evaluation analysis, and replace Bar Code and promote the accuracy of existing application, and execute the optimization. In this stage, they should promote enterprise’s productivity, and reduce the demand for manpower and drive JIT production or logistics. At the same time, real time strategy support should be started to provide internal stocks and personnel tracking and achieve the prompt procedures of automation. In the last stage, we should change the operation mode of enterprise, increase new profit and collaborate with external customers or supplier, and trace goods historical record. Eventually, commodities can be accurately traced both internally and externally through the value chain of Figure 5.

From the value chain framework of IBM, we learn that RFID Tag is attached immediately after commodities (products) are produced, and they are monitored with RFID during production line, and RFID Reader is also set in the stock area to actually read each item and quantity of stock. When commodities is delivered to logistics, RFID Reader of logistics center reads the Tag, and the commodities are delivered by forklift that is installed with Reader to storage area. At this time, the information will be sent back to server, and enterprise can compare the accuracy of stock quantity and can also gather statistics of the stock quantity at present for the convenience of adjusting procurement strategy. When stocks leaving factory, RFID reader of packing area will read the quantity of stocks leaving the factory. In addition, division area is also installed with Reader, and eventually, the commodities is delivered to stocks leaving area, and before stocks leaving warehouse, there is one more RFID Reader to once again report back the information to server. After goods leave logistics center, they will be delivered directly to customer’s warehousing area. There is RFID Reader in the warehousing area, which can rapidly check over the items and quantity through the database connected by Middleware, and then goods covering unit on-site allows the commodities to pass through sensor gate of RFID Reader in arranged order to the display shelves of market. Furthermore, the display shelves are also installed with RFID Reader to monitor the inventory and sales condition, and lastly, customers can quickly pay up at the counter, which is installed with RFID Reader.

VI. SUMMARY AND CONCLUSIONS
RFID has made further progress under the promotion of Taiwan government with great exertion, but comprehensively surveying the progress of advanced countries such as Europe and United States, the pace is obviously slow. And besides the software and hardware promotion, the aspect that really influences the whole effect is strategy aspect. The facilitating strategy of RFID has already been decided since the beginning, where the strategic error not only is incapable of reaching the set target, but also wastes money and manpower, and enterprises’ hanging back is also predictable. Hence, the feasibility of actual strategy will be discussed, and reference to successful examples for modification will be need at any time. In the following, we sort out the facilitating strategy that should be constructed to be the reference:

a. Develop the complete end-to-end solution program
  1. Simplify the facilitating process
  2. Reduce facilitating cost
  3. Reduce the facilitating risk and uncertainty
b. Establish counseling team
  1. Enterprise flow path analysis
  2. Draw up application range
  3. Provide assistance in evaluating ROI

Of course, RFID is not the substitute of Bar Code, but observing from each aspect, besides the ID identification provided by original Bar Code, RFID is even more superior to Bar Code in many aspect. Such as time shortening, reduction in manpower demand, value chain visibility and etc, are all a part of RFID big and powerful superiority. In the future, when RFID integrates supply chain into demand-driven formation, it even shows forth RFID value in supply chain.

REFERENCES