The Effects of Fragmented Industrial Solutions - A Case Study on a Medium Size Manufacturer

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Industrial and Management Engineering

POSTECH
Smart Manufacturing in Small and Medium Enterprises
The Korean government has set up a Smart Factory Promotion team to support SMEs to adopt smart manufacturing:

- Provide customized support depending on maturity level.

The maturity levels are as follows:

- **Level 1**: No solution
- **Level 2**: Production Monitoring
- **Level 3**: Equipment Control
- **Level 4**: Production Optimization
- **Level 5**: Automated Manufacturing

The key features at each level are:

- **Level 1**: No solution
- **Level 2**: Production Monitoring
- **Level 3**: Equipment Control
- **Level 4**: Production Optimization
- **Level 5**: Automated Manufacturing

The diagram illustrates the progression from basic to advanced smart manufacturing capabilities, highlighting the importance of data collection and utilization.
Adopting operation management solutions such as MES, ERP, PLM, and SCM as a first step toward smart manufacturing

- Maturity level of SMEs which receive subsidies from government

- However, the benefit of adopting industrial solution is not dramatic

- Even worse, 80% of SMEs don’t use adopted solutions
Use Case
Company overview

- Industry: Cosmetic packaging
- Products

- Area served: Worldwide
- Founded: 1983; 36 years ago
- Operating income: US $ 5.2 million (2018)
- Number of employees: 1,554 (2018)
Industrial solutions in this SME

- 8 Industrial solutions adoption step-by-step

- Enterprise Resource Planning (ERP)
- Manufacturing Execution System (MES)
- Sales Network System (SN)
- Warehouse Management System (WMS)
- Mold Management System (MMS)
- Quality Management System (QMS)
- Enterprise Asset Management (EAM)
- APS

Timeline:
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
8 Industrial solutions adoption step-by-step

- Enterprise Asset Management (EAM, Facility team)
- Warehouse Management System (WMS, Inventory team)
- Mold Management System (MMS, Mold team)
- Quality Management System (QMS, Quality team)
- Manufacturing Execution System (MES, Production team)
- Sales Network System (SN, Sales team)
- Enterprise Resource Planning (ERP)
- APS

Each team adopts its own solution without communication
Effect - Inconsistent data (1/2)

- Each solution has different data value
  - Inconsistent production record
  - Example: Work order 180803040-0101

**<ERP Production record>**

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Available Inventory</th>
<th>Inventory usage quantity</th>
<th>Production quantity</th>
<th>Conforming product quantity</th>
<th>Defective product quantity</th>
<th>Unprocessed product</th>
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<td>1</td>
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<td>0.00</td>
<td>4,163.00</td>
<td>4,090.00</td>
<td>133.00</td>
<td>0.00</td>
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</table>

**<MES Production record>**

<table>
<thead>
<tr>
<th>데모센터</th>
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<th>CAVITY</th>
<th>Planned quantity</th>
<th>Equipment count</th>
<th>Conforming product quantity</th>
<th>Defective product quantity</th>
<th>Defective rate</th>
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<tr>
<td>1</td>
<td>징후</td>
<td>0.96</td>
<td>1.35</td>
<td>1</td>
<td>1</td>
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<td>426</td>
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<td>3,006</td>
<td>4,030</td>
<td>426</td>
<td>9.6</td>
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</tbody>
</table>

Much time and effort should be put into verifying the data
Effect - Inconsistent data (2/2)

- Each solution has different data value
  - Mold status is different depending on the systems

- Specification change
  - No data
  - Inadequate maintenance schedule

- Old specification
  - Mold assignment failure
  - Mold master data management failure

Inconsistent data can lead wrong decision making
Each team uses its own semantics for their convenience

- Example) Inventory by product

<table>
<thead>
<tr>
<th>Product No.</th>
<th>Spec</th>
<th>Inventory quantity</th>
<th>Unit</th>
<th>Inventory quantity (this ago)</th>
<th>Inventory quantity (1month ago)</th>
<th>Inventory quantity (2months ago)</th>
<th>Inventory quantity (3months ago)</th>
<th>Inventory quantity (6months ago)</th>
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<tr>
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<td>-9,633.00</td>
<td>13,560.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Effect – Communication problem (1/3)

Inventory quantity = received product – returned quantity

Other teams can not understand
Effect – Communication problem (2/3)

To get data, additional contact is required

**Inventory team:**
Is my production plan up-to-date?
→ Ask to the production team

**Post-production team:** I received a standard sample, what is the this material ..?
→ Visit sample team

Much effort, time required
Slow response
Effect – Communication problem (2/3)

Direct contact is required to get data

**Inventory team:**
Is my production plan up-to-date?
→ Ask to the production team

**Post-production team:**
I received a standard sample, what is this material ..?
→ Visit sample team

**Purchase order:**
1803P0002-12

Same representation, different semantic

**Production team:**

**Equipment innovation team:**

**Sales team:**

Much effort, time required
Slow response
Effect – Communication problem (2/3)

Direct contact is required to get data

Inventory team: Is my production plan up-to-date?
→ Ask to the production team

Post-production team: I received a standard sample, what is the this material ..?
→ Visit sample team

Production team: Production rework orders are indicated by P in the order number!

Equipment innovation team: Equipment test orders are indicated as P in the order number!

Sales team: Sample orders are indicated by P in the order number!

Purchase order: 1803P0002-12

Much effort, time required
Slow response

Same representation, different semantic

Same purchase order, leads different understanding
Non standardized terminology

- Same meaning, different terminology
  - Order management/Lot No./Order number, Product number/Material number/Part number, Product name/PO.NA, ...

- Different meaning, same terminology
  - Material(Equipment material/Production material), Order number (Order number/Order management number), Delivery date(Request delivery/Modified delivery), ...

Effect – Communication problem (3/3)

Misunderstanding between different team
Effect – Low data reliability

- Poor data management
  - Example) This order is shipped to buyer in 2018

Second process is carried out despite there was no available inventory, no production

The order is already shipped but data said it is 'in progress'

Work order that consists of 6 process

Actual available inventory was not zero

2017.08-2018.07 Of the 227,523 work orders, 16,219 work orders (7%) are still in progress.

System distrust, data analytics failure
Root causes of the effects

- Inconsistent data
- Low data reliability
- Fragmented Industrial solutions
- Communication problem

**Technology**
- 8 Industrial solutions developed for each team
- There was no data synchronization function

**Company culture**
- People resist change
- Use Excel file rather than solution
- Lack of awareness of importance of standard, data

**Silo**
- Each team doesn't have to share their data, no motivation for data sharing
Propose 3 steps to resolve the problem

1. Problem identification
   - Scenario based data tracking
     - e.g) Complain root cause tracking,
     - Tracking cause of inventory increase

2. Problem resolution
   - Develop a master data management strategy
   - Develop standard message schema

3. Monitoring
   - Dashboard for manager
### Problem identification:
Complain root cause tracking through data

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<tr>
<th>접수유형</th>
<th>택배유형</th>
<th>접수일</th>
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</table>

The amount of returned products are 13,248. What happened?
AMOREPACIFIC claims that the product has burr on product.

How could the defective product be shipped?

Customer claims tracking through the Data

Vendor production → Receipt Inspection → In-house production → Shipment inspection → Buyer receipt inspection

<table>
<thead>
<tr>
<th>공정</th>
<th>연번</th>
<th>접수일</th>
<th>접수유형</th>
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<tr>
<td>단순상품</td>
<td>AP 입고반응 _ 내정기 파팅생산 전함</td>
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<td>고객사명</td>
<td>아모레파시픽 제약사업本社</td>
<td>통행/품명</td>
<td>KAPK090028/라네즈 스킨 밸럼 EX 베이스 30ML 홍기(수출동-0360~0362)</td>
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<td>수량</td>
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<td>발생 ( 불량: 신용_3H / 투명_17 / 투명_17) 80% (G7작인)</td>
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<td>문서현황</td>
<td>Image Close</td>
<td>파일_Burr.png(100.00KB)</td>
<td></td>
<td></td>
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</table>
Questions about shipment inspection data

Q1. Burr inspection is carried out. Why did not you know it at the time of inspection? Was there a problem in delivery?

Q2. Is inspection method wrong?

Q3. Does operator always follow standard sampling?

We found one problem. But it is not the root cause of claim. Let’s take look at ERP, which has in-house production data.

A1. It’s a domestic order, so distortion happens rarely during the shipment.

A2. We adopted standard sampling method such as KS A 2859, KS A 3109.

A3. In fact, operator doesn’t always follow standard sampling method.
Questions about in-house production data

Q1. First printing process is not performed, but second printing process is performed. Wrong routing? Wrong data? Two process can be performed simultaneously?

Q2. Why some process is still ‘in progress’?

Q3. Why data in ERP and MES are inconsistent?

A1. Incorrect data. Inventory was used.

A2. The process is completed, it is wrong data.

A3. Operator enter quantity through POP, after that the data is uploaded to MES and ERP. If the data is incorrect, operator modified only ERP data.

Oh we found 3 data problems I still can not figure out the cause ... Let’s go back to QMS, which manages Receipt Inspection Data.
Questions about receipt inspection data

Q1. There was no defective product record on receipt inspection.

Q2. Does different material cause the problem?

Q3. Why some mold number have different format?

A1. Actually, receipt Inspection also has same problem with shipment inspection (Not following sampling standard).

A2. Material is not different. Data is wrong.

A3. That’s incorrect data. Vendor “Dooin’ uses BO624F, the other vendor ‘D&Tech’ uses BO624G.

I found other problems. But still don’t figure out the cause. We need to investigate the mold. Let’s look at ERP and the Mold management system.

<QMS>
Questions about Vendor’s production data

Q1. It was impossible to determine which vendor has a problem on the system.

A1. Let me check ... Vendor ‘Dooin’ had a problem

Q2. What was the root cause of the problem?

A2. Mold didn’t fit correctly.

Q3. There is no record about mold repair in any system

A3. It will be updated after repair.
Problem resolution

- Develop a master data management strategy
  - One single master reference source for all critical business data

- Develop standard message schema
### Monitoring

- **Report by system, not by paper**

### <Revenue/Order status>

<table>
<thead>
<tr>
<th>Region</th>
<th>Company</th>
<th>Period</th>
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<th>Criteria</th>
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Maintain accurate and up-to-date data
Conclusion
Conclusion & Lessons learned

- Data can not be utilized if the solutions are fragmented
- Manufacturing solutions are burden to people if they are fragmented
- Many solutions don’t guarantee success of smart manufacturing
- Fragmented solutions leads fragmented works, vice versa

- ‘Adopting solution with standard’ can prevent fragmented industrial solutions and other potential problem like security problem
Question?