Harnessing the Power of Digital Technologies in Paper Board Conversion & Despatch

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Abstract:

In the contemporary landscape of the paperboard industry, digital transformation is pivotal for enhancing operational efficiency and productivity. **This paper explores the potential of integrating advanced automation in the Tamil Nadu Newsprint and Papers Limited (TNPL) through the deployment of the Modern Sheet Cutter** within the framework of Enterprise Resource Planning (ERP) and Programmable Logic Controller (PLC) systems. In addition, Paper also details about the validations and controls pertaining to loading/despatch/Invoice of goods to customers by using advanced ERP and API integrations.

The Modern Sheet Cutter, renowned for its precision and adaptability, offers various modes of operation, including single reel, joint reel, and parallel reel without trim. This study focuses on optimizing these modes to eliminate errors in cutting size and significantly boost production output.

The automation of the Modern Sheet Cutter within the ERP and PLC systems is aimed at achieving seamless synchronization between machinery and digital control systems. By automating the cutting process, Industry can reduce human error, enhance cutting precision, and ensure consistent product quality. The integration of different operational modes enables the system to handle diverse production requirements efficiently, thereby minimizing downtime and maximizing resource utilization.

One of the primary objectives of this automation project is to eliminate the incidence of wrong cutting sizes, a common issue that hampers productivity and leads to material wastage. In addition, to control/eliminate wrong despatches/Invoices to customers by system implementations. The implementation of PLCs ensures real-time monitoring and adjustments, allowing for precise control over the cutting process. Additionally, the ERP system provides comprehensive oversight and management of the production workflow, facilitating data-driven decision-making and continuous improvement.

This paper presents a detailed analysis of the automation process, highlighting the technical specifications, operational benefits, and potential challenges. The results demonstrate a significant increase in productivity, with the capability to avoid a wrong cutting size and wrong despatches. The findings underscore the transformative impact of digital automation in the paperboard industry, positioning TNPL at the forefront of innovation and operational excellence. This research contributes to the broader discourse on industrial automation, offering valuable insights for other enterprises seeking to leverage digital technologies for enhanced efficiency and productivity.

Key words : Automation, Resource Utilization, Operational Excellence

The Power of Digital Transformation

Digital technologies have revolutionized manufacturing and logistics across industries, and the paperboard sector is no exception. From streamlining production workflows to enhancing inventory management and logistics tracking, integrating ERP solutions offers a comprehensive framework to synchronize operations. This transformation not only accelerates decision-making but also ensures real-time visibility and control over critical processes.

Paper mill operations are much more complex and require precise integration between various critical points. Wrong sizing and dispatches occur due to manual errors, lack of real-time tracking, and insufficient communication between critical points. With intense competition and high customer expectations, minimizing errors is critical. This paper proposes leveraging

digital technologies to create a robust dispatch management system.

Companies can implement various systems and mechanisms to control and minimize human error. Here is a detailed analysis and suggestions.

Enhancing Efficiency and Accuracy

By centralizing data and operations within an ERP system, Modern Sheet Cutter PLC can eliminate silos and inefficiencies that often plague manual or disjointed systems. Automated data entry, precise forecasting, and synchronized scheduling enable swift response to market demands while minimizing errors in order processing and inventory management. This integration fosters a leaner, more agile operational model, driving productivity and customer satisfaction.

LITERATURE REVIEW

Current Challenges in Paper Mill conversion and despatch management

- Manual processes prone to errors

- Lack of real-time visibility and tracking

- Impact of wrong sizes/dispatches on cost and customer satisfaction

Almost no companies show the percentage of wrong dispatches publicly. However, there are several industry insights that indicate a general trend of improvement in logistics and dispatch accuracy. Over the last decade, the logistics and transportation industries have increasingly adopted digital tools and technologies to enhance efficiency and reduce errors. This includes investments in warehouse management systems (WMS), transportation management systems (TMS), and real-time tracking technologies. Companies are leveraging predictive analytics, big data, AI, and machine learning to streamline operations and minimize operational and dispatch errors Reports suggest that these technological advancements have significantly reduced error rates. For instance, leading logistics companies have seen performance improvements of 10 to 20 percent in the short term and 20 to 40 percent within two to four years due to digital transformations. These improvements imply a reduction in wrong sizing dispatches. Reference -1&2

ISSUES FACED IN PROCESSING SHEET ORDERS

The paperboard industry faces various challenges that can impact its operations, efficiency, and profitability. One of the **most prominent issue is the number of sheet sizes received from customer orders**. The following are the potential issues faced due to enormous sizes involved.

1. **Machine setup and changeover:**

   a. Frequent size change in sheet cutter for different sizes.

   b. Time loss during size change, reducing overall productivity

   c. Increased wear on slit knife and equipment.

2. **Production efficiency:**

   a. Increased downtime between size changes

   b. Challenges in optimizing cutting patterns to minimize waste

   c. Increased potential for errors during frequent size changes

3. **Equipment limitations:**

   a. Some sheet cutters may not be versatile enough to handle all required sizes

   b. Potential need for multiple sheet cutters to accommodate

enormous sizes

4. **Knife management:**

   a. Different sizes may require different knife configurations\

   b. Increased knife wear due to frequent changes and adjustments

   c. Higher knife replacement and maintenance costs

5. **Operator skill requirements:**

   a. Need for highly skilled operators who can quickly and accurately set up machines for various sizes.

   b. Increased potential for human error during setup changes

6. **Setup and adjustment:**

   a. Input of Correct sizes and other cutter settings for different sizes

   b. Setting up of optimal blade positions, pressures, and speeds for various board types and sizes

7. **Cost implications:**

   a. Higher operational costs due to increased setup time and reduced efficiency

   b. Potential need for investment in more versatile cutting equipment

MANUAL SETUP OF SIZES IN SHEET CUTTER

Although enough automation are available in paper board industry from Machine to despatch. Certain parameters in Cutters and Rewinders are given manually. These areas have higher potential for IT-OT improvements in Paper board industry.

Out of the above-mentioned issue in while processing enormous sizes, this paper focus on the manual setup and adjustment on sizes in Cutter considering the following.

a. High level of precision required to ensure accurate Input in Sizes, Knifes, cuts across multiple size changes

b. Intensive Care required in monitoring cut quality and making micro-adjustments.

c. Cautious record-keeping of machine settings for different sizes to improve future setups

The above steps in turn makes way to high skill requirements for operators and which can further lead to following challenges for paper board mills:
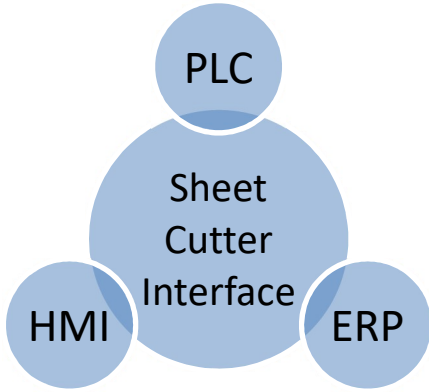
✓ Reduction of wrong size.

✓ Increased risk of Financial and Production loss.

✓ Quality issues when the parameters are not correct.

✓ Higher in processing time.

Addressing these challenges often involves a combination of robust training programs, clear standard operating procedures, essentially **Need of IT-OT improvements in cutting technology is vital.**
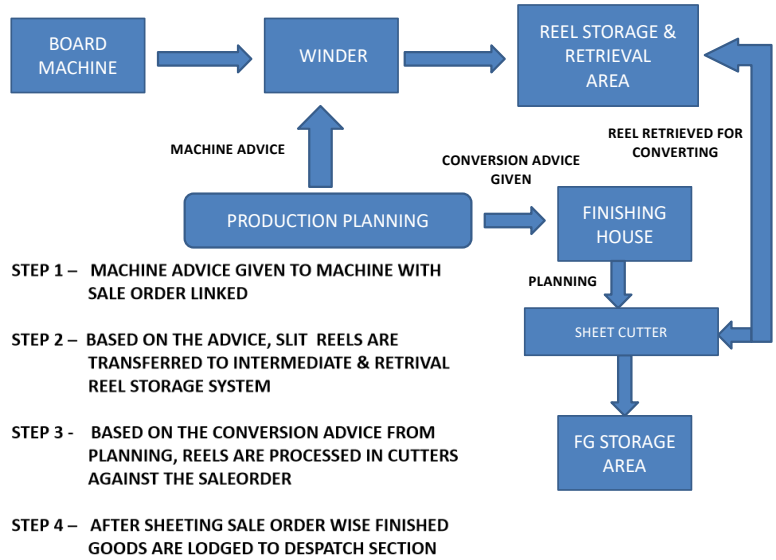
MODERN SHEET CUTTER ERP AUTOMATION

In the competitive realm of paperboard conversion and despatch, the integration of ERP (Enterprise Resource Planning) systems stands as a trans-formative initiative for Sheet Cutter PLC. This strategic adoption of digital technologies promises to streamline operations, elevate accuracy, and propel overall business performance to new heights.

In this case study, we have integrated modern sheet cutter with ERP Module so that necessary setups (Size change, No. of ream per pallet, No.of ream sheets per ream, Reel width and Reel Diameter) interfaced to PLC without any manual intervention.


STEP 1 – MACHINE ADVICE GIVEN TO MACHINE WITH SALE ORDER LINKED

STEP 2 – BASED ON THE ADVICE, SLIT REELS ARE TRANSFERRED TO INTERMEDIATE & RETRIVAL REEL STORAGE SYSTEM

STEP 3 – BASED ON THE CONVERSION ADVICE FROM PLANNING, REELS ARE PROCESSED IN CUTTERS AGAINST THE SALEORDER

STEP 4 – AFTER SHEETING SALE ORDER WISE FINISHED GOODS ARE LODGED TO DESPATCH SECTION

Flowchart 1 - Process Flow Chart From Board Machine To Finished Goods.

Sheeter & ERP Interface flow

Case Study – ERP to PLC Interface Form in Modern Sheet Cutter

Brief Description:

In order to check reel operation in sheet cutter with interface form. Reel with unique barcode label loaded in unwind stand, with the help of interface form reel data transferred from ERP to PLC.
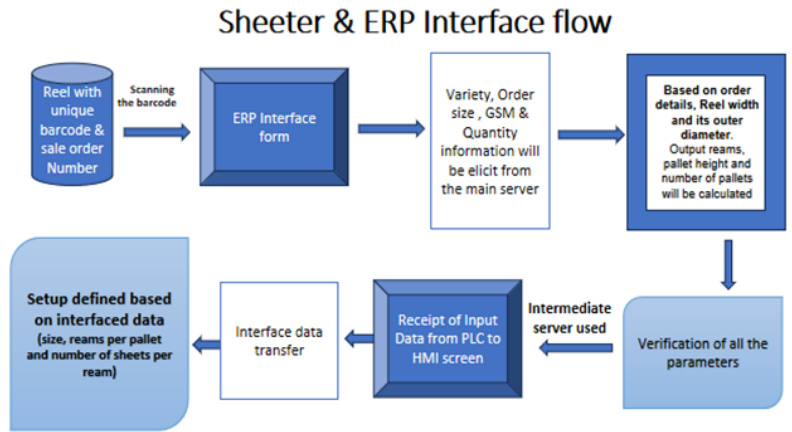
SEQ NUMBER	LOT	ITEM CODE	ORDER NUMBER	FG ITEM CODE	REEL_LENGTH	REEL_WEIGHT	CONSUME_REEL_LENGTH	BALANCE_REEL_LENGTH	CONSUME_REEL_WEIGHT
92205000 02	BW14202210000/704009C	BW4NAPES02900175C2	62021008217	B4NAPES02900269010004C200 0	6250	3122	2548	3702	1252
42205000 03	BW14202040060110009C	BW4NAPES02900149CC2	62021008252	B4NAPES02900510066009C200 0	7404	2888	2102	5212	771

VAR	GSM	WIDTH	LENGTH	NO_OF_CUT	NO OF SHEET PER REAM	NO OF REAM PER BUNDLE	REEL WIDTH
AFE	280	59	91	3	100	4	177.5
AFE	230	51	68.5	3	100	8	155

The input data for sheet cutter displayed from PLC to HMI Successfully. As shown in screenshot

Screenshot 1:
HMI ERP Communication Page – New Message A1 Request

This streamlined process ensures efficient handling of operations, integrating ERP functionalities seamlessly with production tasks and avoids wrong size issue.

Results and Discussion

The above the case study performed in TNPL Unit 2 Sheet Conversion Process. The following benefits are attained.

1. Reduction of Manual Operations.

2. Validation and control in Wrong Sizing.

3. Considerable Loss and Cost saving,

4. Reduction in Process time.

5. Timely delivery of FG to improve customer Satisfaction.

6. Real time calculation of Reject gate loss, trim loss and handling loss.

## POWER DIGITAL TECHNOLOGIES IN PAPER BOARD DESPATCH AREAS
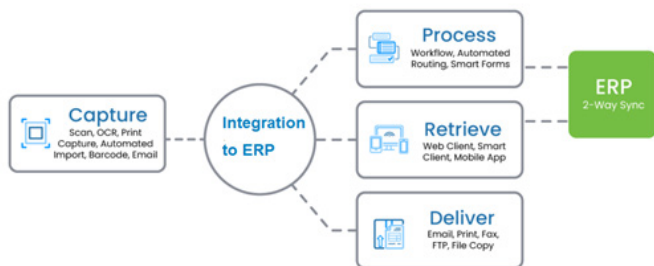
Flowchart 2 -. Process Flow of FG Stock Receipt and Despatch.

Warehouse management system

Most of the Warehouse management systems use the **Auto ID Data Capture (AIDC)** technology, which include the following to efficiently monitor the flow of products.

1. QR codes/bar codes and mobile computers. (PDA)

2. Radio frequency identification (RFID)

3. biometrics (like iris and facial recognition system)

4. Magnetic stripes and optical character recognition (OCR)

Once data has been collected, a real-time wireless transmission is done to a central database. The database can then provide useful reports about the status of goods in the warehouse. It is used from the Stock Receipt to Invoicing to Customers. Each and every data to be interfaced with ERP/Database in order to avoid data loss.
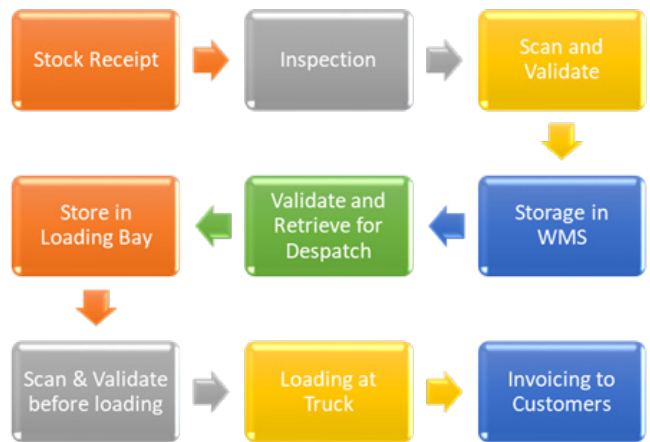
5 STAGE VALIDATION OF GOODS.

In order to check the correctness of good received against customer order. The FG Stocks are verified at the following stages.

1. Finished Goods Receipt Validation with Customer Orders.

FG Stock with lot numbers are scanned with a static scanner/Mobile scanner and the input is connected/synchronised with ERP or the database for checking the Correctness of the Product instantaneously.

• If the data is correct, (received items match the expected SKU/Order) and flow is found ok, the FG lot is passed on to the next step in the conveyor or manually pulled.

• If the Stock lot contains duplication or not matching to the prescribed order or specification. The products are rejected and sent to the by-pass lane. The same is rejected to production area for further correction.

2. Stock Storage at WMS as per Customer Order.

FG Stock with lot numbers are scanned with a static scanner at the WMS, Later the based on the validation check, the Stock are fed into the system as per the customer orders. Stacking is made automatically with cranes or manually with a forklift based on the system built in the mill. Also the Stacking to be done on FIFO basis to have better stock ageing.

3. Stock Retrieval from WMS as per Customer Order.

In WMS, the stock is fed out based on the Customer Order. FG Stock with lot numbers are brought down from the vertical storage by Crane on FIFO Basis. Necessary Scanning is made after retrieval

4. Stock loading as per customer order

Once the stocks are received from WMS, the Stocks are made ready for Loading the truck. The Final FG lots are again scanned with a static scanner or mobile scanner for the correctness of the following.

a.   Item/SKU b. Quantity.   c. As per customer Order and Specification/Quality Parameters.

In case Stock lot does not pass the above parameters, the products are rejected and sent to the by-pass lane. The same is rejected to go down area for further correction.

5. Invoicing to Customer.

Based on the scanned data of lot numbers and Sale orders. The necessary data is sent to ERP for Invoicing. With the Confirmed data, the invoice is raised in ERP. With invoice data, the details are automatically pushed to Government server (IRP) by API Integration. E-Invoice is generated with IRN details and sent back to ERP. After necessary data QR code and IRN is given to Customers.

eInvoice (IRN) for India – Process flow

By following these validation steps, mills can significantly improve the accuracy and efficiency of finished goods receipt and dispatch processes. This systematic approach helps minimize errors, reduce shrinkage, and enhance overall supply chain visibility.

Results and Discussion

The above process is performed with **Auto ID Data Capture (AIDC)** technology with Bar code or QR codes for Validation. This Process is successfully integrated in TNPL Unit 2.

In order to attain enhanced accuracy, lower human intervention and less time. Mills can integrate to the following

a)   **Automation scanning solution** is used to scan products that run on the conveyor belts in a factory with both Laser Automation and Image Automation Scanner. This can be done in Conveyor belts from receipt areas to warehouse and from storage to direct trucks.

Although these **conveyor and static scanner arrangements have high initial costs**, their **operational expenses will be very low in the long run**. Moreover, they can reduce both time and human intervention.

b)   Radio Frequency Identification (RFID) Tracking:

I.   RFID tags can be attached to individual products, pallets, or entire loads, allowing real-time tracking throughout the supply chain.

II.   Fixed RFID readers at loading bays and shipping docks automatically verify that the correct products are being loaded onto the designated trucks or containers.

III. Any discrepancies between the RFID data and the order details are immediately flagged, prevents wrong dispatches.

IV. Benefits
   i.   Reduces human error in picking and packing
   ii.   Enables real-time tracking of inventory
   iii. Improves order accuracy and customer satisfaction
   iv.   Speeds up the dispatch process

V.   Challenges:
   i.   Initial setup cost can be high
   ii.   Change in Existing system Setup and Training.

Most of the Leading companies use RFID for various purposes, including inventory management, supply chain optimization, asset tracking, and enhancing customer experiences.

Conclusion

One of the primary objectives of this automation project is to eliminate inaccuracies in the Sheet cutting and Sheet chopping sizes of paperboard. To prevent errors in pallets per ream and sheets per ream on Modern Sheet Cutters, by utilizing the ERP Interface effectively.

Digital technologies offer a transformative potential for despatch management in paper mills. By integrating API and advanced analytics, mills can achieve significant improvements in accuracy, efficiency, and customer satisfaction. The proposed solution, supported by a robust implementation framework, can serve as a model for the industry, paving the way for a more efficient and error-free future.
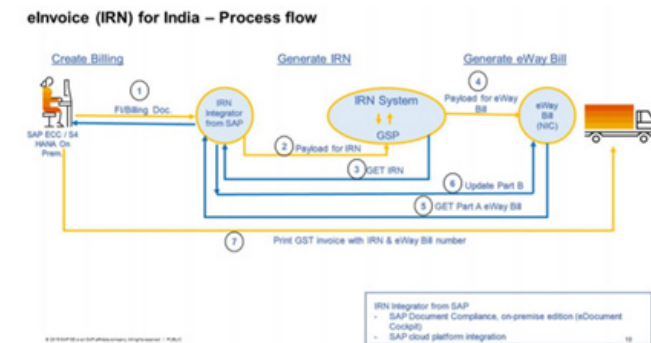
Acknowledgement

Abbreviations used

• ERP - Enterprise Resource Planning • API – Application programming interface • PLC - Programmable Logic Controller • HMI - Human Machine Interface • WMS – Warehouse Management System • TMS - transportation management systems • FG - Finished Goods • AI – Artificial Intelligence. • AIDC - Auto ID Data Capture • PDA – Personal Digital Assistant • RFID - Radio frequency identification • OCR - optical character recognition • SKU – Stock-Keeping Unit. • FIFO – First in First Out • IRN – Invoice Reference Number • QR – Quick Response. • IRP - Invoice Registration Portal

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