Original Research

Design of an integrated in-line traceability and ERP system – A case study approach

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Abstract
Aftermarket services need to track and trace their manufacturing processes and activities to eliminate untimely warranty claims. In this paper, we propose a system that allows manufactured products, including child components, to be traceable, which directly benefits the aftermarket service functions. A relation between a product and the components that are being manufactured is a prominent feature of the model. Identification processes are fundamental in order to establish the connection between physical products and digital means. A classification of item codes and a traceability model that describes and generates product identification is proposed. With parent-child relationships, all these inputs are automatically generated and deployed and consumed while generating a parent product order on the system ledger. The framework is linked with the existing ERP system and the design flow is prepared to integrate the framework to the practical production system. In the end, this results in complete product traceability throughout the product lifecycle.

Keywords - classification codes; inline; manufacturing; system integration; traceability

Introduction

Traceability is an essential need of latest quality management systems. Companies that have implemented this system are required to prepare and maintain documented procedures to identify the product, from the purchase of raw materials through the manufacturing process and shipment, in accordance with the ISO 9000 management standard. These standards and similar systems aim to ensure constant product quality during manufacturing. A good traceability system is latent to minimize unsafe practices and poor-quality products in supply chain (Aung and Chang, 2014). Within the make-to-order products, the core objective of traceability implementation is to achieve increase in the quality of products. In general, the quality requirements of products are known before the product is produced. Moe (1998) as well as Aung and Chang (2014) suggest that quality assurance should be upgraded with the traceability system as one of the sub-systems. Moe (1998) pointed out that traceability system is an essential subsystem of quality assurance.

I. Manufacturing Traceability

The role of traceability in manufacturing processes is to enable the history of events to be followed and compared with anticipated plans and predefined objectives. To detect system status, assess system performance and sustain decision-making, tracing techniques can be used. Traceability is characterized as "the ability to trace an entity's history, application or location through recorded identifiers" according to ISO 8402. Aung and Chang (2014) declared that traceability system is a critical subsystem in addition to Good

Manufacturing Practices (GMP) and Hazard Analysis Critical Control Point (HACCP). Regattieri et al (2007) considered the traceability framework as a method for meeting quality standards and linking suppliers and consumers with relationships. Agrawal et al (2021) presented block chain based product traceability system to have sustainable supply chain network. Reddy et al (2021) looked at the use of block chain technology in the automotive supply chain and presented a framework that improves information transparency and visibility among stakeholders. In make-to-order products, it is possible that the traceability system can support quality assurance implementation as a path to reduce mistakes and spare parts required and processing recommended in previous studies that investigate traceability in manufacturing. In order to display a graphical list of raw materials, spares and subassemblies, Jansen-Vullers et al (2003) considered traceability information systems using Gozinto graph modelling. Van Dorp (2003) used the Gozinto Graph, a tree-like graphical representation of components and subassemblies, in which, through a series of manufacturing and assembly operations, a specific production process transforms into an end product. Saleeshya et al (2012a) demonstrated the adoption of suitable marking and tracing techniques for packages in process manufacturing sector like textile industry. Discrete manufacturers can monitor every product that makes up a component from vendor to producer to completion and shipping to customers by creating family tree. It can be accomplished in a variety of ways, including using technologies such as engraving for this type of producers, in which components and parts are permanently labelled either when they complete the process or by vendors. Engravings can be applied in a variety of ways in the parts that need identification. Once the methods of traceability are selected, and then decide which lot identification is required based on the assembly operations. Robson et al (2007) used traceability to efficiently and automatically trace spare parts in automotive industry. A few of the studies developed traceability system to support quality assurance implementation in manufacturing. Organizations differ greatly in their understanding of an approach and their implementation approaches (Saleeshya et al., 2012b; 2013). Colledani and Angius (2020) modelled the process and methodology for evaluating the performance of product excellence and dependability in manufacturing processes that are subject to product inspection, allowing for in-line defect detection and correction. The application of CART model and fuzzy inference models are discussed by Siddharth et al (2019) to monitor petroleum refinery industries on real time. The objectivated agility realization model was developed by Saleeshya and Babu (2011) to estimate the measure of agility at various hierarchical levels of manufacturing organisations. Schuitemaker and Xu (2020) looked at how three essential areas of reverse logistics, architecture creation, deployment methods, and data science, have similarities and variations. The use of an electronic-based traceability system would mitigate the negative effects of automation on manual procedures, increase product throughput speed and inventory accuracy while reducing transaction errors, labour intervention, and necessary cycle time Chryssochoidis (2009). The application of Quick Response Codes and printable labels in traceability systems is discussed in Tarjan's (2014) study. The concept of traceability and that is to offer customers with access to essential product data. At important points in the production run, data can be transferred to product labels like barcodes. It is vital to guarantee that the suggested system operates quickly and accurately by printing relevant codes on the packaging during production and allowing the product's user to read the data quickly and easily. The tests were carried out on a variety of substrates on which the data were inscribed. In addition, the legibility of the Quick Response code in the condition of geometrical distortion was investigated. The best way to manage the company's business processes is determined by continuous and constantly evolving specifications. Chen et al (2019) indicated the results that the traceability of the products increases company's operating efficiency and profit growth rate post implementation. Bashir and Qadir (2006) revealed that the traceability is crucial to manage updations and measuring its influence on productivity. They give an overview of current traceability techniques that can be used to detect issues, as well as the requirements for evaluating existing traceability techniques. They show that existing traceability strategies are inadequate in many situations, which can lead to issues with requirements management for rapidly evolving business processes. It is also suggested to combine current traceability approaches to address process management issues and optimize traceability benefits through the synergy of the methods. Chandran and Saleeshya (2020) modelled the objectivated lean attainment model for the improvement of efficiency and productivity of the systems in service sector organization. Vanany and Rahmawati (2014) revealed that the development of a quality assurance traceability system presented a huge opportunity to help quality assurance activities in make-to-order companies as well as for customers. The vehicle preventive diagnostic system with system integrated approach was developed by Yankevich (2019) to monitor and predict the possible failures in the sub system level.The traceability method is commonly used in a number of industries manufacturing different products, food products like fish (Abad et al, 2009), fruits (Manos and Manikas, 2010), and also in manufacturing sector products such as food processing (Moe, 1998), automotive industry (Robson et al, 2009), and aircraft industry (Harun et al, 2008). In manufacturing industries aspect, the traceability system is used to trace from material in spare parts or raw material until finished product. Many specialists believe that the core objectives of traceability implementation are supporting systems in industries to ensure products are safe and are of good quality. Galvão et al (2010) believe that traceability system is not only a route to ensure food safety but also ensures quality of spare parts or raw materials and recommended processing machines.

II. "Traceability"-the next major manufacturing challenge

We consider the case of a project "Z" run by a company located in India which produces wiper products for locomotives. The initiative's principal purpose could be to limit the scope of potential recalls and the economy is considered with them. All items that are possibly affected must be reviewed manually if any problem is found. If the defective materials have been already supplied, investigations should be performed at the customer's or end user's location. This results in extra expense for sending people to the location of the customer for the analysis. If the materials are assembled and functioning at the consumer's location, the recall expenses would be much higher and in some scenarios it costs penalties. It is more difficult than ever to figure out exactly how, where and when the product was produced, since the production line is gradually adapting to multinational contexts as well. Lot of products that are produced and used are cheaper, simpler, and easier than ever before. Customers who desire to act professionally struggle with this for several reasons, but businesses do as well. The challenge as well as its resolution shall be simplified to one aspect is called "traceability". It establishes precise and detailed visibility in the production process. The components made in the production line will quickly detect and repair problems in the production line before they multiply. Most of the companies do not own all the subsidiaries that make components of their goods, so detailed data management is a major challenge. Due to the higher cost for secondary inspection and fines, opportunities for significant savings are limited by recalls.

III. Traceability execution in manufacturing

It is clear that the efficacy of the traceability scheme is based on the technological implementation of content, part and product identification methods in general. A future direction in the growth of the industry is demonstrated by the implementation of track and trace method in the present processes. It shall provide complete details on the product and its progress in order to avoid deception and to reduce the costs of re-issuing parts in the event of batch identification of defects. It is possible to consider a product lifecycle as a sequence of events encountered by a product. Such activities include not only the actual production, but also the service offerings that accompany the item throughout its existence. This results in integrated traceability offerings of products and systems. Product monitoring and tracing, service triggering, and service delivery are major challenges in this context.

CASE STUDY

This paper is paying attention on designing the tracing and tracking model in a manufacturing line in a compressor manufacturing company in India, which is a pioneer in compressor and automotive equipment business. The company manufactures a broad range of compressed air products from Rotary screw compressors; reciprocating and centrifugal compressors both in oil- lubricated and oil free segments. Also the company provides air accessories, heat recovery system, railway compressors and its components. The industry is having presence over 120 countries with 60 years of market presence and with 2 million installations worldwide. The emergence of globalization, caused by increased competition and greater customer demand has necessitated modernizing the system and incorporating advanced technologies.

The implementation of the identification and tracking system in the current manufacturing setup is a promising direction in the growth of the industry. The company needs traceability in their aftermarket services to track and trace their production processes and operations. The focus of this paper is on the railway components. In this segment, the manufacturing line of wiper assembly is considered for our study to implement tracking and tracing of the product.

PROBLEM DESCRIPTION AND METHODOLOGY

The wiper assembly has variant designs and within the model variants, some of the components are interchangeable and some are not. In the current manufacturing line, while releasing the production order, the fabrication (FAB) serial number is generated only for the parent part number. Post physical assembly and testing of components the serial number for the child parts are manually allotted and written in a ledger. Then the serial numbers are engraved in child components and hence there is no link established between the parent and child parts. Current process sequence of wiper assembly is shown in Figure 1.

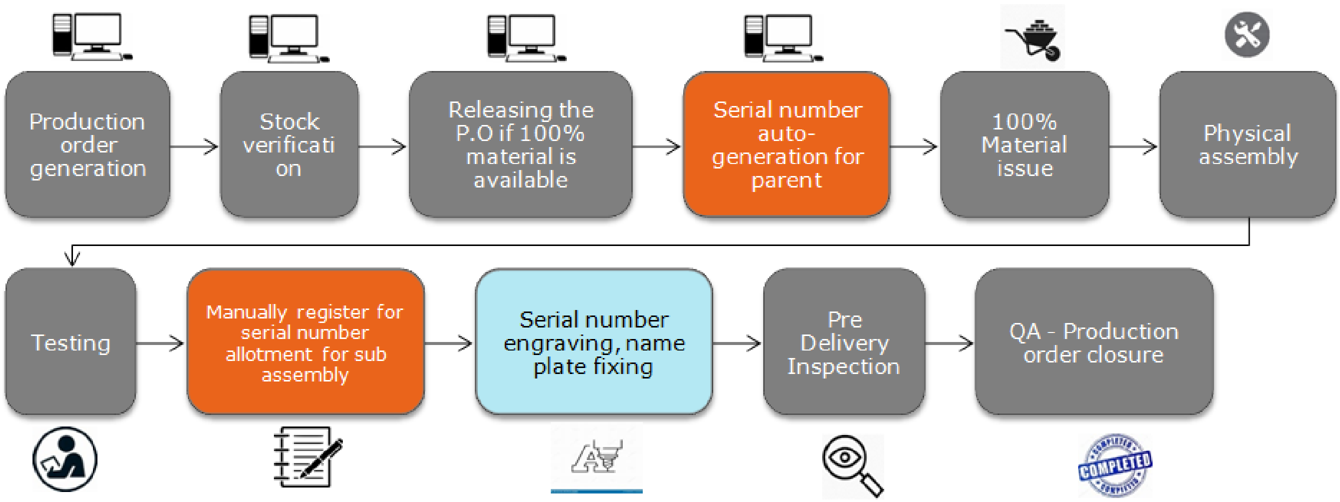

FIGURE 1
WIPER ASSEMBLY MANUFACTURING FLOW

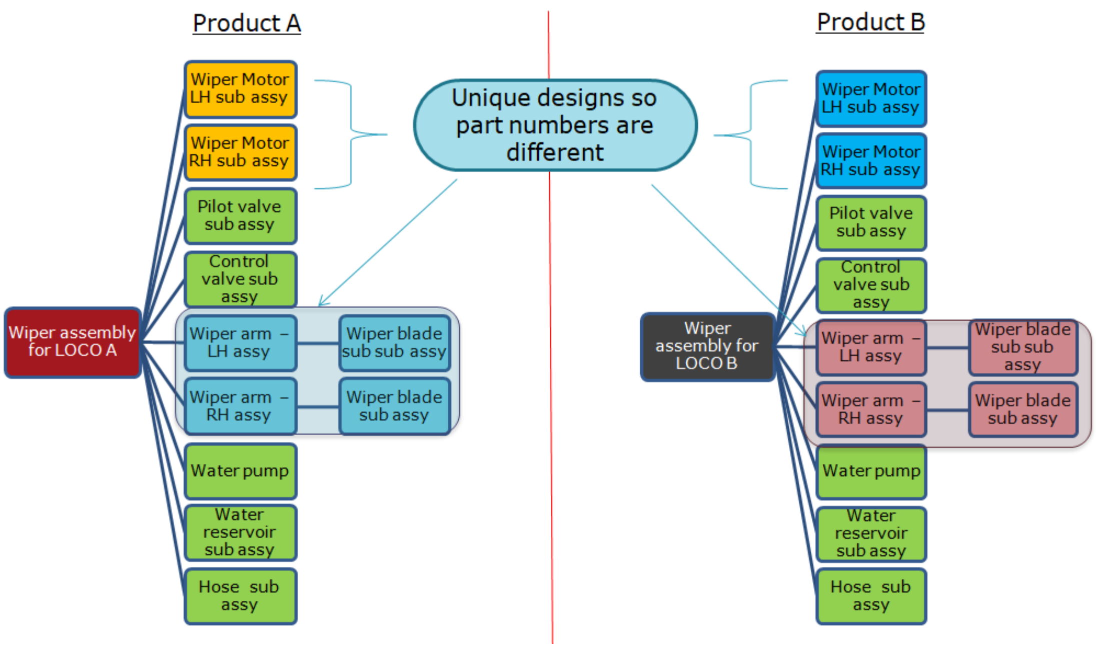

FIGURE 2
PRODUCT VARIANT - ILLUSTRATION

The following problems have been identified with the current system.

- Difficulty in analyzing the root cause of the quality issues during in-process and in field.
- Due to non-traceability, warranty expired parts are replaced in free of cost.
- Unable to perform periodical maintenance due to nil tracking mechanism.

The objective is to design an in-line traceability information system for wiper assembly manufacturing. This will ensure that all the critical items and subassemblies in the wiper manufacturing process can be traced. An index of specific product identification will be developed by considering product dynamics. The track and trace capability is established in the production line as well as in the field. It also improves recall management by enabling reverse lookups. It will reduce warranty claim costs and the on-time service ensures higher uptime. We

ANALYSIS OF FINDINGS OF CURRENT STATE

As per the bill of materials (BOM), the Product assembly A shares some of the components to Product assembly B, as

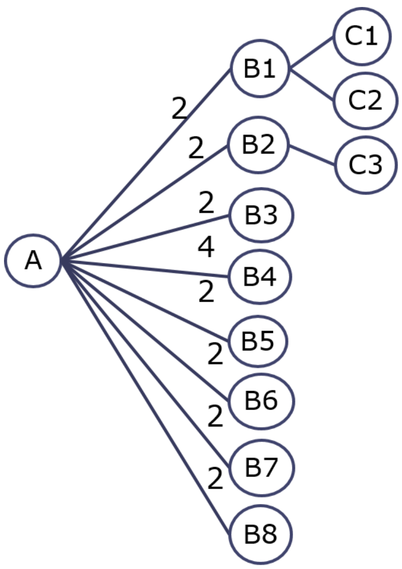

FIGURE 3
GOZINTO MODEL – MATERIAL MATRIX

DEVELOPMENT OF TRACEABILITY INFORMATION MODEL

I. Goesinto graph

For industrial production components, it is possible to indicate the number of individual parts the assembly is made from and how many units of volume are required for the production of the product unit. Vazsonyi jokingly coined the term by referring the approach to the Italian mathematician Gozinto, whose name stands for "the part that goesinto".

The product structure data is derived from the product's BOM. To build a product tree for the product, this BOM can be used. The nodes symbolize the parts, assemblies, and finished product. Link arrows display the direction of the flow of material. The strength of the material flow is indicated by quantities next to the arrows. However, since several parts are included in multiple end products, such a representation is redundant. Therefore, a more compact display form was developed, called the Gozinto graph. In the Gozinto graph, all parts and relationships occur only once, avoiding data

are thus proactively amending the production processes to optimize the product quality.

is shown in Figure 2 The products may be produced in different time periods, and sent to the same customer. And subsequently the components are interchanged at customer location due to various reasons. If any failure occurs or any scheduled maintenance has to be performed, it is very difficult in the current scenario.

redundancy. The Gozinto map thus helps to demonstrate graphically the bills of materials that are often contained in today's database systems.

TABLE I
LIST OF PARTS IN AN ASSEMBLY WITH ITEM GROUPS

Level	Item	Legend	QTY	Relationship	Item Group
0	Wiper assy	A	1set	Parent	
1	Motor Assy RH	B1	2N	Child-1	P00-Phantom
1	Motor Assy LH	B2	2N	Child-2	P00-Phantom
1	Control Valve Assy	B3	2N	Child-3	5M-Casting
1	Blade Assy	B4	4N	Child-4	5M-Casting
1	Reservoir Assy	B5	2N	Child-5	P00-Phantom
1	Arm Assy LH	B6	2N	Child-6	5M-Casting
1	Arm Assy RH	B7	2N	Child-7	562-Fly Wiper
1	Water Pump Assy	B8	2N	Child-8	P00-Phantom

Figure 3 and Table 1 shown here describes the list of parts used in an assembly and the parent-child relationship with the number of parts is also accounted. As shown here, the product assembly consists of eight child parts with various quantities. Two of the assemblies have further child parts.

TABLE 2
2ND LEVEL BILL OF MATERIAL WITH MAKE/BUY CODE

Lev el	Item	Description	QTY	Item group	m/b code
1	435A	Motor assy	2N	P00-Phantom	m
2	1030	Valve body	1N	5S2-Rly wiper	b
2	1040	Holder-p	1N	5S2-Rly wiper	b
2	1050	Seal-P	1N	5S2-Rly wiper	b
2	1060	Ermeto	1N	5S2-Rly wiper	b
2	1070	Plug	1N	5S2-Rly wiper	b
2	1080	Rubber pad	1N	5S2-Rly wiper	b
2	1140	O ring	2N	5S2-Rly wiper	b
2	2110	Name plate	1N	5S2-Rly wiper	b
2	2133	Sealing ring	1N	5S2-Rly wiper	b
2	1210	Gasket	1N	003-Misc	b

All necessary component items, including the requisite sum for the parent item's manufacturing, are established in the parent-child association. A multi-level system will explode when , it is possible for a component item to be a parent item in and of itself before the component items are no longer produced goods but purchased items, as seen in Table 2.

To facilitate and establish an item-based traceability of products, it becomes essential to identify products unequivocally for them to be distinguishable individually. All wiper components mentioned in Table 1, require traceability Table 3 shows the existing item groups and the suggested new item groups and the unique identity of each sub assembly.

TABLE 3
LIST OF ITEMS WITH NEW ITEM GROUP

Level	Item	QTY	Old Group	New Group
0	Wiper assy	1set	P00-Phantom	646-package
1	Motor Assy RH	2N	P00-Phantom	W01-MRH
1	Motor Assy LH	2N	P00-Phantom	W02-MLH
1	Con. Valve Assy	2N	5M-Casting	W03-CVA
1	Blade Assy	4N	5M-Casting	W04-BLA
1	Reservoir Assy	2N	P00-Phantom	W05-REA
1	Arm Assy LH	2N	5M-Casting	W06-AAL
1	Arm Assy RH	2N	562-Fly Wiper	W07-AAR
1	Water Pump Assy	2N	P00-Phantom	W08-WPA

TRACKING AND TRACEABILITY FUNCTIONALITY REQUIREMENTS DESIGN

I. Bill of material (BOM) lot

Manufacturing should be responsible for tracking and trace which lots contributed to the structure of a specific final product batch, as per tracking and tracing criteria. Lots used in manufacturing are always recorded throughout the system so that the mixture of the finished product may be determined backwards to its different parts. Each parent unit must consequently keep track of its sub-assemblies' identification. Noting all relationships between child and parent material lots provides a technique of tracking the mixture of the finished product.

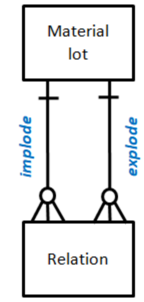

FIGURE 4
BOM LOTS

A multilayer BOM lots can be created while its complete flow of actions necessary in production of specific finished product corresponds to this recording of relations. The data in that BOM lots shown in Figure 5 is then used to detect the mixture of a final item made up of component lots (backward tracking) and all final goods that have utilized a given component lot of activity (forward tracking).

Manufacturing BOM lots are made up of two types of entities (relation, lot) and two types of relationships (implode, explode). BOM lot's unique designation and accompanying data properties are stored in the lot structure. Lot entity features include item identity, name, and unit volume, original amount, remaining amount, and ordering type. A relation's unique identity and accompanying records are stored in the relation structure. Relation entity features include things like the exact start date, the exact amount of utilized material, and the final output. The entity claims that the combinations of child and parent material lot numbers are distinct.

II. Wiper assembly process- Operations and Variables

Tracking and tracing needs in production operation necessitate particular data on actual process executed rather than normal processes. As a result, practical processes are always linked to the completion of a production order for a particular product. During an operation, materials are transformed within specified limitations and according to specific operational directions. Mostly as a result, publish of various parameters is critical for tracking and tracing.

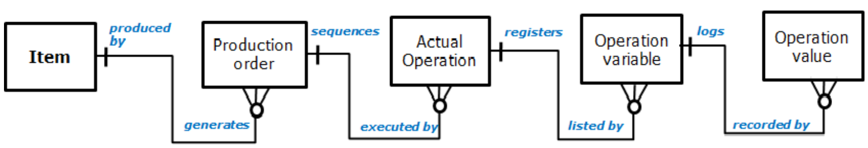

FIGURE 5
OPERATIONS AND VARIABLE MODEL

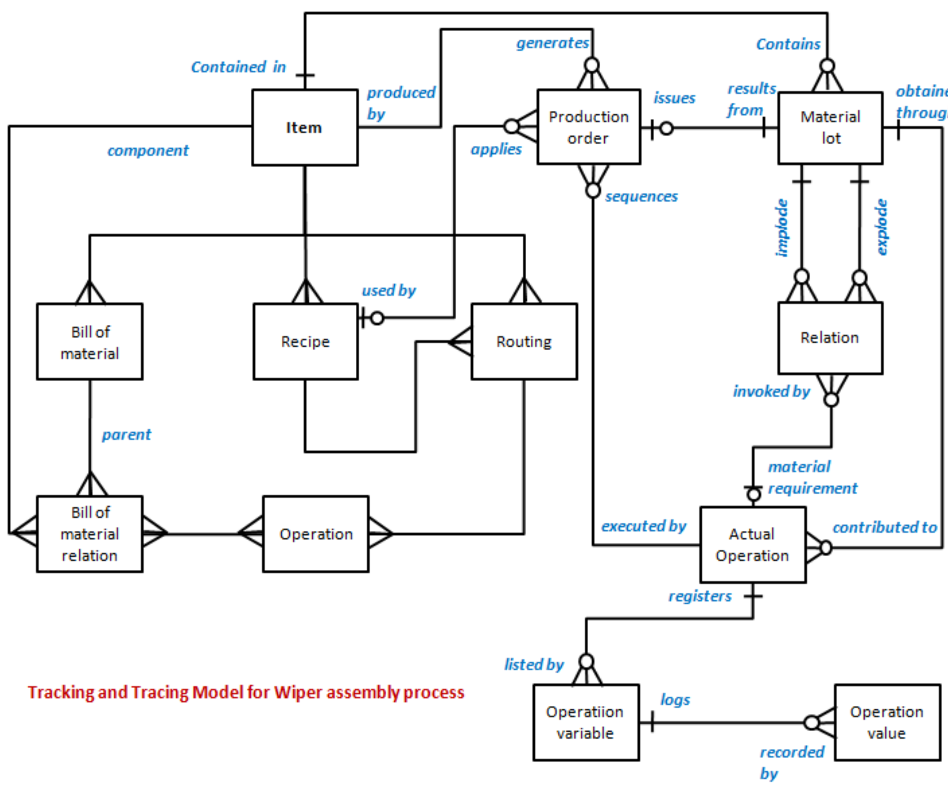

FIGURE 6
TRACEABILITY INFORMATION MODEL

As a result, the input parameters of operation elements must be linked to the actual operations performed. Figure 5 shows this capability as well. Furthermore, the real operation carried out

should be linked to the maximum throughput in which this is carried out. Factors considered on the model design are Entities, Sub entities, Quantity, Relationship and Data type.

III. Preparation of Traceability information model

Figure 6 displays traceability information model. The framework describes the manufacture of a product as a result of the completion of a production order. A BOM lot containing the production component is issued by the production order. The BOM lots are used to track the material components utilized in the item's manufacture. As a result, all material components remain traceable under the production order because they are associated with the item's final BOM lot. Furthermore, the flow of events under the production order could be tracked. The material consumption is also tracked, as are the batches of output that produced. Moreover, due to the storing of process parameters and outcomes, the efficiency of each process may be reviewed in great detail.

IV. Traceability information model- Structure layouting

The TRACE_PRODUCT entity (in Figure 7) is used to store traceability data files. The tracking id of item instance is indicated by the identification attribute (e.g. a serial number). The data sources are stored under the name called 'integrated wiper_ schema.document_reference'. There are two forms of manufacturing traceability records namely Static and Dynamic data. Static deals on resource, Dynamic deals on the product's sub-tasks and processes. Information for the identification of materials, instruments, and staffing involved in supervisory, operator, and other tasks is classified as static data. The cycle time information and other data required to repeat the process sequence are included in dynamic data. Tracing assembly processes entails following the sequence of operations. Each time an assembly process is carried out, a unique set of traceability objects is generated. These entities track resources (such as a model, number, an item group, Serial number) as well as process variables like time, etc.

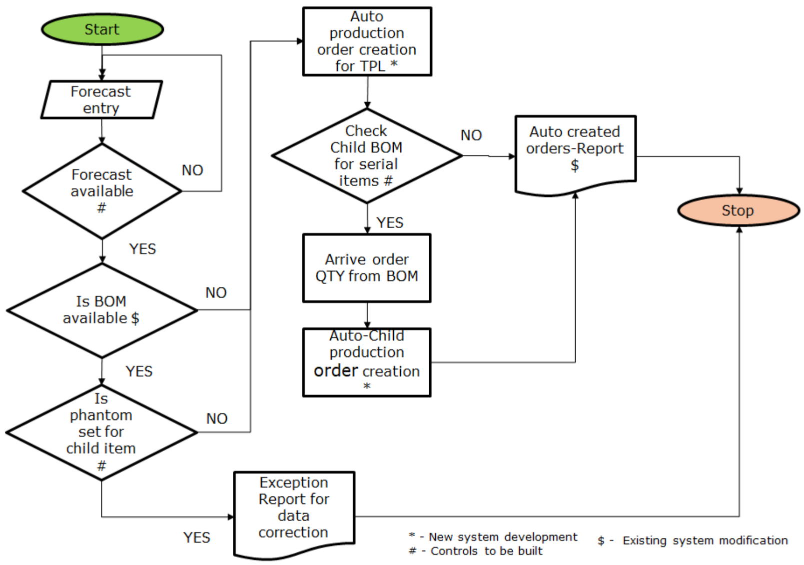

Figure 7
STRUCTURAL LAYOUT OF TRACEABILITY MODEL

ERP SYSTEM DESIGN FLOW

I. Defining process inputs and output controls

The transaction modes in Enterprise resource planning (ERP) are also defined based on the nature of process, the various process steps and it controls based on the inputs and required outputs. For each transaction types and inputs, the pre-requisites (requirements) are captured. Process owners are well defined for each of the processes to have better clarity

II. ERP - Defining the design flow for Auto production order creation

The process is started when the forecast entry is captured. If the forecast is available, the bill of material (BOM) availability checking process is enabled;

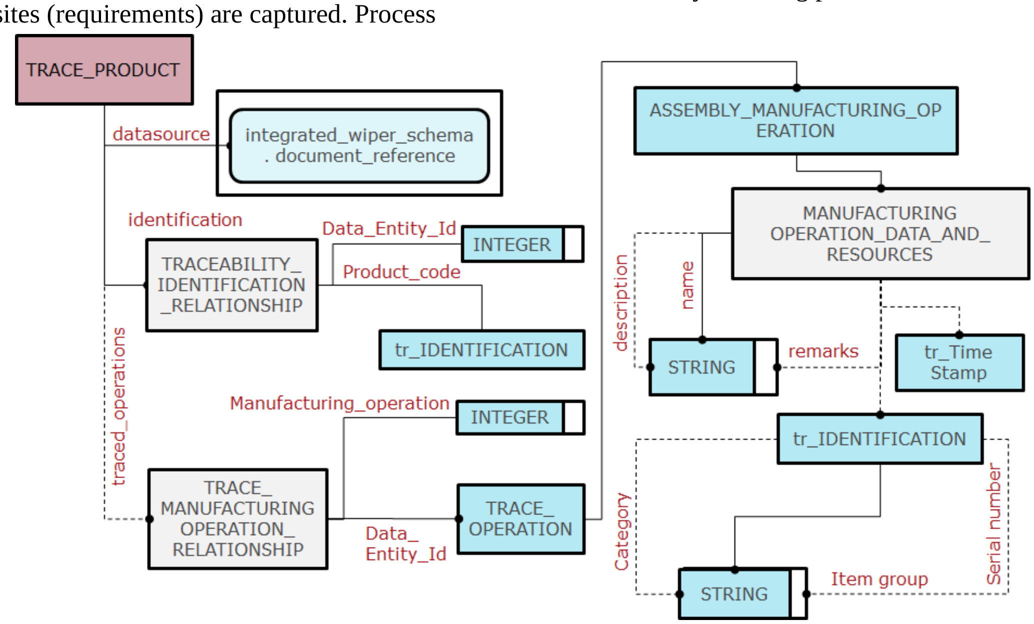

FIGURE 8
Flow of auto production order creation

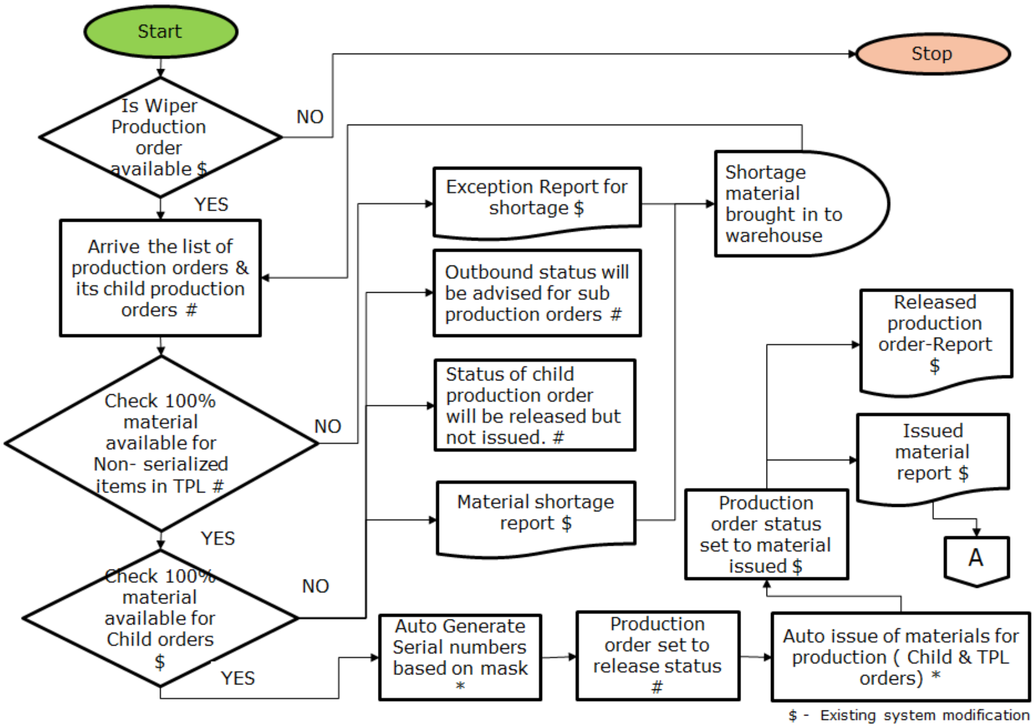

FIGURE 9
FLOW OF MATERIAL ISSUE

If the forecast entry is not available it will wait for the forecast to start the process. BOM is not available; it will trigger the auto production order creation for the Total part list (TPL), otherwise it would evaluate the whether the phantom is set for the child items, if the answer is "YES" the system would capture as an exception and it will generate the exception report. If Phantom set is "NO" it will trigger the auto production order creation for the TPL. Figure 8 shows the design flow for auto production order creation. In further the child serial item's BOM check is performed, when it is available the BOM quantity is arrived and auto production is created for all the required child items and it will be captured in the "Auto- created production order report". When the BOM is not available also it will be captured in the "Auto-created production order report".

III. ERP - Defining the design flow for material issue

Once the production order (P.O) is created it would check the category is wiper product or not. If "YES", the system would arrive the list of items required for the TPL and also for child production orders.

Then it would check for 100% material availability pertaining to the non-serialized items in the TPL. Figure 9 shows the design flow for material issue. If the 100% material availability is ensured, the serial numbers for each order would be generated automatically based the mask set. The next stage is "set to release status" of production order, when it is set, material issue to the Child and TPL orders will be performed automatically. This also ensured in the next stage "set to material issued". All those information's and transactions are registered in "Release production order report and also in "Material issued report" separately.

If 100% material is not available for the TPL the exception report for shortage would capture the information, once the shortage material brought in to ware house, again the process triggers to arriving the list of item for the P.O. meanwhile the outbound status will be advised for sub production orders and status of child production order will be released but not issue. All these information's are recorded material shortage report.

IV. ERP - Defining the design flow for order completion

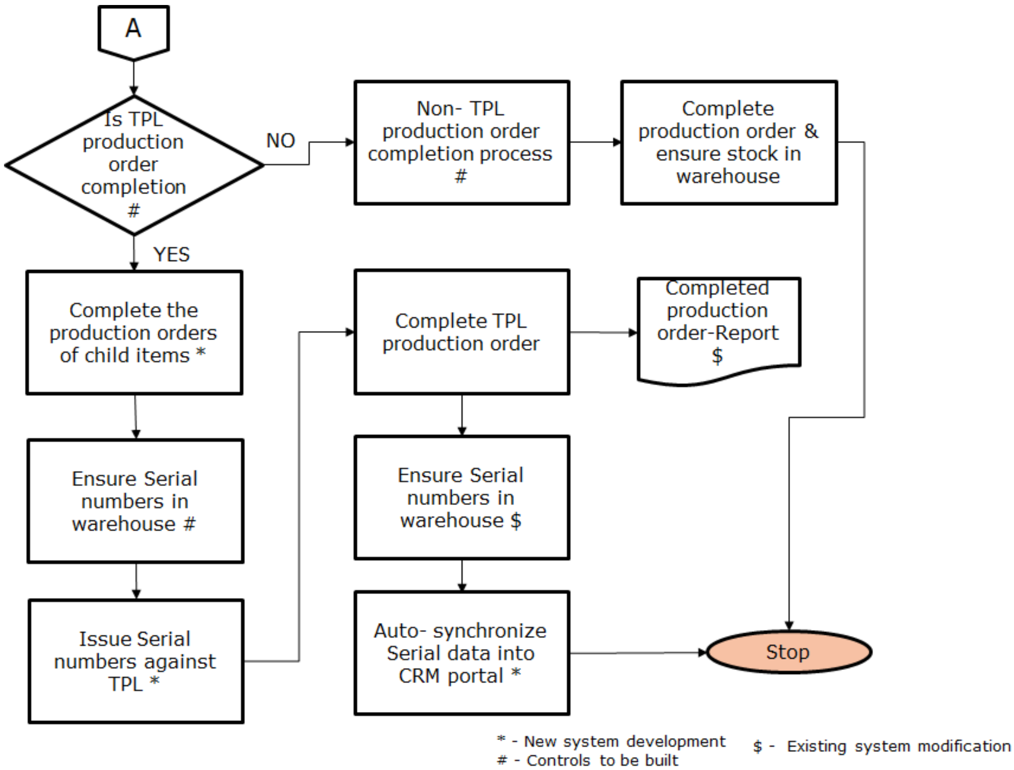

FIGURE 10
FLOW OF ORDER COMPLETION

Figure 10 shows the design flow for order completion. In this stage, the system checks whether the production order is pertaining to the TPL and Non-TPL item. If "YES" it will complete the production orders of child items first and record the serial numbers in the warehouse. Serial numbers would be mapped against each TPL, then the production order is completed. Completed production order's serial numbers are allocated based on the requested warehouse. Serial data is auto-synchronized with customer relationship management (CRM) portal. All these information's are recorded in the report is called "Completed production orders report".

If the production order pertains to Non-TPL item, it will be routed to Non-TPL production order completion process, complete the production order and ensure stock in warehouse.

V. ERP – Modifications and new system development

It consists of three phases, viz., existing system modification, new controls to be built and new system development. We will discuss in detail about these three phases.

Production order creation stage:

1. BOM availability check: All Wiper products sub assemblies' phantom to be set as "NO". Masks should be defined and serialized for sub and main assembly.

2. Auto created orders-Report: Modification of auto created production orders and reports to be compiled as per the requirement.

The fields which are applicable to the wiper product assembly would be filtered and made as default. Phantom option would be unchecked for all the wiper product assemblies. With this report the production order with status, production order number, quantity requested and the delivery status w.r.t each wiper assembly would be captured and available in the ERP system. This report would be enhanced with the provision with automatic creation of child production orders along with parent production orders which are applicable to the wiper product assembly. The unique report ID also would help to quick retrieval of data.

Table 4 shows the unique serialization logic w.r.t BOM quantity for each production order. It shows the bill of material levels and quantities with unique item group for each item category. The item groups for the each product along with production order will helps to generate unique identification and this leads perfect traceability of child assemblies along with parent product. Same product with different production orders with unique serial numbers would be generated based on the item group and quantity.

TABLE 4
NEW ITEM GROUP FAB NUMBER LOGIC

Item group	Running serial w.r.to quantity	Fab logic
B	01	FAB0221A001
B	02	FAB0221A002
C	01	FAB0221A003
C	02	FAB0221A004
D	01	FAB0221A005
D	02	FAB0221A006
E	01	FAB0221A007
E	02	FAB0221A008
E	03	FAB0221A009
E	04	FAB0221A0010
F	01	FAB0221A0011
F	02	FAB0221A0012

	S.NO	Production orders	Fab number
Parent item : 4090	1	20002875	FAB0221A111
	2	20002876	FAB0221A216

Material issue stage:

Check 100% material available for Child orders. The shortage report generation for Main TPL / sub part list / sub assy (SPL) to be modified to address 100% shortage including sub production orders. Based on the shortage list - triggers would be setup. Execute only after 100% direct child and indirect child material availability in a TPL and SPL. FAB number generated through sub production order will be issued in main production order. If any material shortage found production orders, outbound status will be advised for sub production order and status of sub production order will be released but not issued. In this case, main production order status will be as Production order planned / document printed. Material shortage report, Released production order-Report, Issued material report to be modified including all the required fields

Production order completion stage:

Issued material report generation for Main / Sub parts to be modified including sub production orders and its item issue status.Data like production order quantity, release status, date and time, assembly status, warehouse reference with unique serial number can be traced. Production order completion along with serial number data capture in the warehouse. Whenever the production order is getting completion, the system should record unique serial number of each sub production orders and also with parent production orders only for Wiper production orders. Once it is recorded the fields to be mapped in to the concern reports to enable the traceability

The controls established at each stage in the existing ERP system are as listed below.

(i) Order creation stage

- Phantom detection controls and checks established in ERP script
- In sub items – Serialization required items mask filtration and identification checks defined
- Auto production order for TPL and also for sub production orders linking controls made

(ii) Order release stage

- Arrived the controls for list of production orders and its child production orders
- Check 100% material available for Non- serialized items in TPL
- Outbound status will be advised for sub production orders
- Status of child production order will be released but not issued.
- Auto issue of materials for production (Child and TPL orders)

(iii) Order completion stage

- Check triggers for the TPL production order or Non-TPL productions orders made
- Controls for Non-TPL production order flow and TPL production order flow to be routed as per the flow process
- Controls for Parent FAB and child FAB numbers synchronized to CRM

VI. ERP – New system development-Requirements

Figure 11 shows the system development to be done on the productions orders on each stage.Each of the production order state, these new developments in the ERP system would give more flexibility and enhancement in the present system which would support for the traceability of the product. These requirements are given here because the types of developments are completely new to the overall production order flow system. The traceability data should also be synchronized to CRM (Customer relationship management portal).

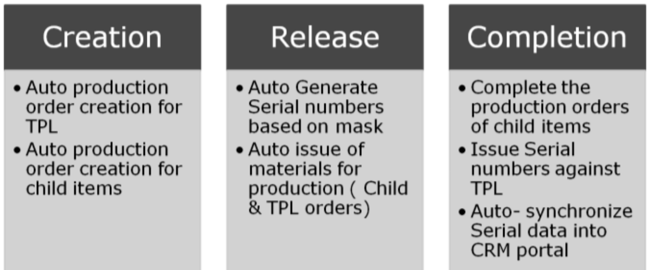

Figure 11
NEW SYSTEM DEVELOPMENTS IN ERP

CONCLUSION

This paper provided an overview of the new traceability scheme and frame work capability. Current scenarios, processes and challenges were analyzed. This paper presents a design work and a guideline enabling in-line product tracking and tracing to track and trace products in production systems operating under product variants. Based on best trends and literature reviews relevant for our assembly process, the model was evaluated and developed. A theoretical guideline for enhancing the traceability of goods in the supply chain is given by the proposed model. The generality of the approach makes it possible to track the products within different manufacturing contexts. In this paper, the theoretical work established opens the way for implementations in many different fields. The track and traceability models for the production of assembly products were proposed and the sub-assemblies of the transitivity and traceability system to the finished products were constructed to enhance the efficiency of the entire process for the entire product lifecycle. Track and trace information can be used to ensure that the correct items are available on-time and ready to use at each processing step, so that paper work would be eliminated and with reduced downtime.

FUTURE SCOPE

The traceability approach is now being integrated with the manufacturing system. Distinct data concepts are being proposed to help with a variety of activities, including the tracing and tracking of critical components and assembly. The tasks listed below could be assessed for potential enhancement.

- The traceability frame work model should be integrated into the production order system.
- Automation has boosted economies around the world by allowing production and infrastructure to keep up with rising demand, and it addresses two key goals: productivity and data protection.

Automation shall be deployed in several application areas in manufacturing. As proposed, the advantages of traceability and visualization can be enabled by the introduction of automation in manufacturing industries, but it also creates vast datasets that require appropriate methods of analysis to enable a thorough understanding of the relationships between products and variants. In the implementation of an automated tracking system, future research areas will concentrate on data analysis and product data management.

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