Systematic Journal Review on S & OP Publications and Avenues for Future Research to Support Smart Industries

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***Abstract*— This research paper attempts to highlight the scarcity of articles published in the field of Sales & Operations Planning (S& OP) in supply chain management. The S & OP process allows Supply Chain Managers to balance demand and supply. Literature in leading journals are limited in the area of S & OP and there is a need to address this limitation to aid efforts to complement the demand planning process in smart industries. In 2010, it was recorded that only 15 papers were published and less than a handful of articles were written throughout the mid-2000s. Additionally, within these limited publications, topics have centered on structural components for operational processes rather than the demand planning or S & OP process. With the advent of big data, internet of things (IOT) and Industry 4.0, there is a need for more articles to be published to support full supply chain integration.**

***Keywords*—** *big data, Industry 4.0, sales and operations planning (S & OP), smart industry*

1. Introduction

The evolution of S & OP can be said to have existed back in the 1980s, having risen out of what was earlier known as materials requirements planning [1]. As fuel prices increased in the 1980s, due to a dependence on fossil fuel, just-in-time (JIT) practices began to emerge to minimize holding costs of inventory held and several studies have led the way in using just-in-time (JIT) in view of rising material costs and scarcity of material supplies [2]. The trend to manufacture in batches has evolved into a lot size of 1 unit in line with smart industries. Smart industries have developed into what has been called a 'smart factory'. The possibility of wide data collection from industrial processes allows smart action for system changes. Such data forms part of big data, which is data that is big in size (volume), big in variety (structured; semi-structured; unstructured), and big in speed of change (velocity) and with connectivity of data of the different production resources (work stations and machines) it is possible to use manufacturing information sharing to create a smart system for predictive and automated decision making processes with potential self-reconfiguration of the production system [3]. Findings from recent studies have shown that more than 70% of organizations have an S & OP process suggesting adoption broadly among large manufacturers but very few papers have been published in the S & OP field. In this study, the researcher plans to search for one key word, namely the word 'S & OP' from articles in leading journals. The main purpose of this study is to determine that there are insufficient S & OP journal publications on supply and demand planning in smart industries. Significance of this study will point to much needed direction and standardisation of processes and terminology in the S & OP process for future smart factories.

1.1 What is S & OP

The areas of sales and operations planning (S & OP) or demand planning attempts to match supply and demand by using a forecasting method to drive finished goods, material, capacity and procurement planning (Figure 1).

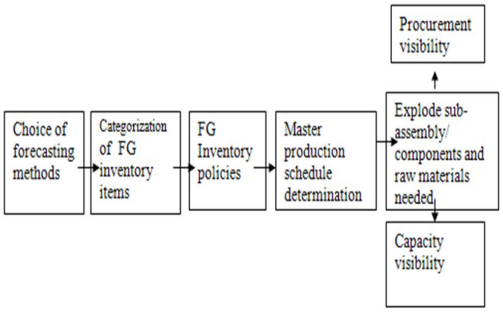

Figure- 1: A typical S & OP or demand planning process. [4]

This area is vital in the fast-moving consumer goods (FMCG) business where many stock keeping units (SKUs) are usually held to support the business. If a supply chain manager gets it right, there is opportunity for the supplying organization to achieve excellent levels of product availability and at the same time avoid excessive levels of excess inventory and capacity. The elements of the S & OP process described in this article stems from the author's experience in the sewing thread batch processing industry where SKU forecasts are made that drives finished goods, material, capacity and procurement planning and it can be used to plan for integration of demand and supply for smart industry processes particularly in attempting to predict and plan output required to meet demand in the modern age.

A forecast is first made for all SKUs in a FMCG type organization, using order history and short-term forecasting methods from data extracted from the organization's Enterprise Resource Planning (ERP) systems. The forecast then drives inventory categorization so that common rules can be used to easily determine replenishment for many SKUs. The replenishment cycles then determine the master production schedule (MPS) which then calculates materials, procurement and capacity required allowing supply chain managers to balance demand and supply [5]. Perishable products impose major challenges on inventory management because stock outs and on-shelf availability are a trade-off against wastage due to expiry. Besides food waste in areas such as fresh produce, dairy products, sauces, bread, many other inventory items expire on the shelves as well, due to low popularity. These include canned food, bottled drinks, confectionery and many household products. Even finished goods (FG) for fashion goods and electronic goods held on shelves tend to become slow moving over time and shelf life ultimately determines policies for inventory disposal. Process industries excluding pharmaceuticals account for €2750 billion in revenues globally and inventories make up 56.7% of working capital for these industries [6] and there is great scope to ensure that the right levels of inventory are held to match incoming demand using an improved S & OP approach. Goh & Eldridge [7] concluded that the implementation of a common yet advanced S & OP process resulted in a 30 percent reduction in inventory levels.

1.2 How is the S & OP process vital for smart industries?

The integration process in smart industries requires the smooth linkage between supply and demand (Figure 2). A 'smart factory' will need an efficient S & OP process to ensure supply matches demand.

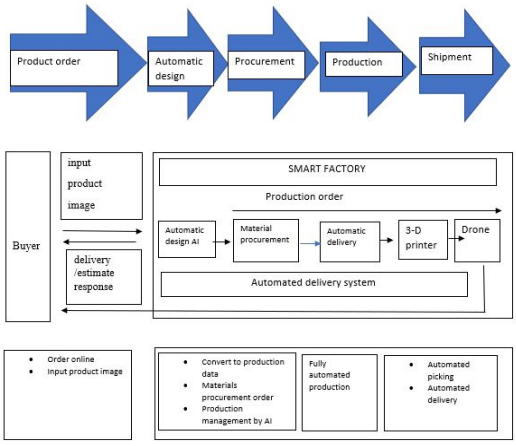

Figure- 2: Fully automated production process in a smart industry scenario [8]

From Figure 2.0, the process from supplies to customers (buyers) use technology and uses a drone assisted automated delivery system. We can note the link between material supplies, capacity and demand and make comparisons between S & OP and the smart industry automated production processes where both attempt to source and manufacture products for the end customer. S & OP has greater emphasis on finished goods planning due to holding many SKUs whereas smart factories will focus on material planning and procurement to manufacture one SKU at a time. The current spread of the internet and development speed of information technology has created more

convenient and better business models and is surely about to change the traditional manufacturing business model [8] but the elements of an S & OP process will be at the heart of a 'smart factory'. Nine technologies have shaped Industry 4.0, namely, autonomous robots, horizontal and vertical integration within industry, the industrial internet of things, cybersecurity, the cloud, additive manufacturing, augmented reality and big data and analytics [9]. These nine advances in technology have formed the basis for smart industries in manufacturing and isolated, optimized cells will come together in the S & OP process as a fully integrated, automated, and optimized production flow. This will lead to greater efficiencies which will change traditional production relationships among suppliers, producers, and customers, as well as between human and machine. In Malaysia, these nine pillars form the basis for aligning Small Medium Enterprises (SMEs) [10].

2. Literature Review

The literature section begins by reviewing the main components of the S & OP process, particularly in the area of demand planning. The areas of forecasting, inventory categorization, inventory replenishment, master production schedules, material, capacity and procurement planning have shaped the S & OP process within organizations from big data collected from legacy Enterprise Resource Planning (ERP) systems. The data can be used as inputs for the modeling and simulation (or aggregate plans) of a smart factory supply chain scenario.

2.1 Forecasting methods

Order history is used to develop forecasts for every SKU in warehouses to firstly develop a pre-forecast before collaborating with Marketing/Sales to further develop the pre-forecast to reflect future events such as promotions. From actual point of sale (POS) data, demand signals are used to fine-tune the pre-forecast into a consensus forecast.

A common problem with short-term forecasts is that they are developed from order or sales history from a relatively long past period (usually 1 year) but recent forecasting have looked at real time POS data to determine more accurate forecasts [11]. For example, Proctor & Gamble use a 5-week forward forecast based on POS data called demand sensing and the objective is to make a forecast that is likely to be as close to the actual demand. The evolution of demand forecasting has followed a path similar to understanding uncertainty [12, 13] and the FMCG business has developed from manufacturing of fairly standardized products using traditional forecasting, to one that produces mass customization of products. The forecasts use downstream demand signals (point of sale, social media, weather data, competitive intelligence and promotions) to fine tune forecasts so that supply chain managers are able to sense demand and get close to the actual demand to make better predictions as far as possible.

2.2 Inventory Categorization

Once the final forecast has been derived through the forecasting process, ABC inventory categorization will help determine inventory policies for inventory replenishment. This will determine scenarios of FG holding (Make for stock, MFS), then deriving materials required for procurement and capacity planning. Make to order (MTO) will also be able to use such forecasts for material procurement and capacity planning.

A point to note in inventory categorization is that it attempts to classify inventory into categories and the most common unit of measure used in inventory categorization is order volume measured in either sales units, cases, pallets, container loads, weight, length or liters. A popular way of categorizing inventory [14], is to classify volume of sales units by SKUs received into ABC categories. While order volume may be a good indicator of size and relevant capacity required, high volume items that are not so popular may result in slow moving inventory. A good benefit of inventory categorization is that it allows supply chain managers to easily set days cover policies for each category for inventory replenishment, thus reducing the complexity of managing many items.

2.3 Inventory Replenishment

The managerial practice for implementing an inventory policy is inventory control. The accountability of inventory control measures sales units at a specific location and monitors additions and deletions. Inventory control systems monitor customer demand and also lead times [15]. When inventory is held, inventory control systems are used to control the level of inventory within the FMCG industry. Demand and lead time will have fluctuations and when inventory reaches a user defined re-order point or level (R), an order (Q) is placed periodically hence a sophisticated S & OP process in smart factory applications will help eliminate slow moving and obsolete materials.

2.4 The use of Master Production Schedules for make or buy decisions

Cycles of Q as per finished goods replenishment cycles impact the master production schedule (MPS). Using the bill of material which is a list of quantities of components, ingredients and materials required to make a product, planned order releases (PORs) are released. The determinations of PORs are detailed and require extensive calculations. However, with the advent of computers and the use of big data, forward requirements can be easily crunched to get meaningful POR projections.

2.5 Material Planning

Material requirements planning (MRP) systems became a prominent approach to managing the flow of raw material and components on the factory floor in the late 20th century [16-17]. Its adoption was not something that happened, but rather a slow progression over many decades. During the formative years, most of the calculations were manual but with changes in computer technology, MRP became the standard approach for managing the flow of material on the factory floor and formed the heart of ERP systems and this aspect will still be applicable in smart industries.

2.6 Capacity Planning

The Planned Order Release (POR) projections in material requirement planning allow supply chain managers to convert requirements into machine hours and view capacity projections [18]. Challenges in capacity planning requires estimating the minimum resource capacity required to meet service level objectives (SLOs) defined for all customer service classes because too much capacity requires high investments in capital expenditure. The high capital expenditure (CAPEX) requirements in process industries force firms to regularly operate at high utilization rates [6] and this in turn creates too much inventory. In the smart factory environment, installed capacity must be just enough to meet demand requirements.

2.7 Procurement Planning

Procurement helps satisfy internal customers at the right price, from the right sources at the right specification in the right quality for delivery at the right time to the right internal customer. Based on POR projections, procurement secures volumes [19]. In the smart factory environment, just-in-time supplies will be required and an accurate S & OP process will facilitate this. This requires developing a strong relationship with suppliers as well as other functional groups within the organization to recognize the inter-functional relationships and outcomes of procurement decisions, requiring more co-operation and coordination than has traditionally existed between procurement and other organizational areas.

3. Methodology

The typical approach for S & OP in past research have been to consider team perceptions of core S & OP team members, typically project managers, as these managers are in a position to assess internal team dynamics [23-25]. The structured questionnaire seems to be most popular with most researchers [26], and much research into the area of supply chain and inventory management have used different approaches such as field data collection, interviews with supply chain practitioners and personal experience [27-28]. Some studies have found that data in demand planning systems can be used to enhance supply chain performance [29] and there is great potential for ERP data to improve inventory performance. Studies by Ref. [30] reviewed demand signals in fresh food value chains for 6 case studies and data was collected from representative products. The data collection method involved steps which included interviews of staff involved in ordering, forecasting and production planning as well as reviewing characteristics of demand information that flows through channels from point of customer upstream to the value chain. Data was collected to track forecasts, consumer demand patterns, orders received for the organization, production and delivery activities and there could be more studies that emphasize the S & OP process. Past S & OP researchers have tended to interview managers' perceptions using the Likert scale and analysed the surveyed data in Statistical Package for the Social Sciences (SPSS) or Smart PLS software. Ref. [31] identified 20 key words in supply chain management and then searched those key words from several sources. The searched extended over the last 15 years. The researchers stated that the approach was because supply chain management is a relatively new field.

3.1 Searching of articles using the key word Sales and Operations Planning or (S & OP) from leading journals

To continue the search for S & OP literature, the researcher searched for the key word 'Sales and Operations Planning' (S & OP) from articles with a range of impact factors from leading journals in the field of operations, supply chain, logistics

management and information technology The sample size of 9733 articles included all articles published by 10 journals (Table 1) from 2013 to 2017.

Table 1: Ten (10) leading journals in the field of supply chain management.

Name of Journal searched	Impact factor	2017	2016	2015	2014	2013
Journal of Operations Management	4.899	19	50	51	37	42
International Journal of Production Economics	4.407	286	283	370	304	382
International Journal of Operations & Production Management	2.955	120	74	61	58	64
International Journal of Physical Distribution & Logistics Management	1.826	48	41	41	41	49
Computers & Industrial Engineering	3.195	450	356	340	245	291
Computers in Chemical Engineering	3.113	293	298	200	257	239
Computers in Industry	2.850	57	93	103	104	120
European Journal of Operational Research	3.428	713	695	676	644	504
International Journal of Forecasting	2.186	78	106	74	94	65
Supply Chain Management: An International Journal	3.833	34	47	49	50	46
Total sample size = 9733 articles searched		2098	2043	1956	1834	1802

4. Discussion

From Table 2, we can conclude that only 13 articles have the key word 'S&OP' mentioned and there is clearly a lack of S & OP articles published.

Table 2: Summary of S & OP journal articles in main journals.

No.	Name of Journal searched	Impact factor	2017	2016	2015	2014	2013
1	Journal of Operations Management	2	0	0	0	0	2
2	International Journal of Production Economics	1	1	0	2	0	1
3	International Journal of Operations & Production Management	0	0	0	1	0	0
4	International Journal of Physical Distribution & Logistics Management	0	1	2	0	0	0
5	Computers & Industrial Engineering	1	0	0	0	0	1
6	Computers in Chemical Engineering	1	0	0	0	0	1
7	Computers in Industry	1	0	0	0	0	1
8	European Journal of Operational Research	0	0	0	0	0	0
9	International Journal of Forecasting	0	0	0	0	0	0
10	Supply Chain Management: An International Journal	0	0	0	0	0	0
	No. of articles found = 13 articles	6	2	2	3	0	6

This is backed by Ref. [28] who say that S & OP has not received much attention in the literature. Ref. [29] say that despite S & OP being widely known, its impact on supply chain performance has been neglected. With the advent of smart factories, we have seen how technology has driven changes to the way manufacturing and distribution will be developed and there is therefore more S & OP literature needed to support manufacturing in smart industry initiatives.

From the steam engine to mass production to robotics, smart industries have developed integrated manufacturing systems that fit in with modern technologies. S & OP has a role to play in smart industries which allows for full integration of the supply chain [4] and there is a need for more

journal articles to be written to support this planning process. We have moved from using Excel spreadsheets for simpler tasks such as project management and routine calculations to manufacturers that now use legacy ERP systems. These ERP systems hold transactional data for organizations and this has developed into big data being used to plan supply and demand. The big players who develop transactional systems, for example, the four top commercially packaged ERP developers (Microsoft, SAP, ORACLE and SAGE) have processes in order fulfilment, production and procurement [30]. This results in transactional data in the areas of inventory and warehouse management, asset management, human capital management, material planning, management accounting and financial management and there is wide scope for the sharing of this data and processes in S & OP publications.

5. Conclusion

Ten leading journals were selected for the search of journal articles and more journals could include the area of S & OP in publications to support the demand planning process defined in this study. However, very little has been done by organizations to share their ERP transaction data mainly because of confidentiality reasons. There is the fear that the data will land in the hands of competitors. However, there is scope for researchers to publish more journal articles using confidentiality agreements and contribute to the S & OP field and the impact that the 'smart factory' will have on Industry 4.0 initiatives. Future research will require publishers to show chronological sequence of changes in S & OP terminology in relation to smart industries. This will support the growing use of the internet and big data. Reports say that almost 90% of big data was developed in the last two decades with the world witnessing an unprecedented interest in big data [31]. While the world at large is talking about big data at the product or tool level and relationships with social media as well as with IOT, very little has been done to integrate big data and the S & OP function.

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