ISSN: 4821 – 4509
Volume 8, Number 2, 2022
International Journal of Marketing, Management and Research

ADVANCED PLANNING AND SCHEDULING APPLICATIONS: A CONCEPTUAL REVIEW

[1]Paul M. Nadube Ph.D and [2]Aguoru, Ugonma Jennifer
[1]Department of Marketing, Faculty of Management Sciences, Rivers State University of, Port-Harcourt, Nigeria, [2]A Research Fellow and Supply chain analyst.

ABSTRACT

Advanced Planning and Scheduling (APS) application is a concept that has received growing attention within the last few years because of its enormous benefits to supply chain and logistics operations. APS application is a set of technologies, business processes, and performance metrics that enable manufacturing companies to compete more effectively in the global marketplace. The technologies involved are computer software and hardware that enable organizations to change the way they plan, schedule, forecast, distribute, and communicate with customers and suppliers This study conceptually explored advanced planning and scheduling applications. It employed review of literature as a means to gain a proper understanding of the concept of advanced planning and scheduling applications. In the initial section, it presented an introduction and a theoretical foundation. Subsequently, it discussed the concept of advanced planning and scheduling applications, and its dimensions and finally presented its theoretical findings and conclusion.

KEYWORDS: Advanced Planning, Scheduling Applications, Demand Planning Applications, Production Planning Applications.

INTRODUCTION

Advanced Planning and Scheduling (APS) applications have become necessary for modern-day supply chain and logistics management as customer demand for varieties of products, fast delivery, and cost-effective services become prevalent. These applications help planners save time while providing greater agility in updating ever-changing priorities, production schedules, and inventory plans. According to Goor, Amstel, & Walther (2019), an APS application is a system that covers the entire supply chain, enabling real-time information to be extracted from that chain. With that information, efficient schedules can be generated, resulting in fast and reliable customer responses. Such systems make it possible to answer customer inquiries within seconds instead of hours or days.

Studies have shown that the effective use of APS tools enables planning cycles, capacity utilization, and inventory levels to be reduced while simultaneously increasing customer service levels. In support of this notion, Amier and Ammar (2010) opine that if APS is implemented correctly, speed in delivery times, accurate inventory levels for raw materials, resource utilization rates in production in real-time, productivity measure of throughput time, improved customer services and reduction of costs in the shape of waste of time and material in production are among the many benefits.

Aligned to the above benefits, APS applications also create optimized schedules that balance production efficiency and delivery performance, maximize throughput on bottleneck resources to increase revenue, synchronize supply with demand to reduce inventories, provide company-wide visibility to resource capacity, and enable scenario data-driven decision-making (PlanetTogether, 2021). Be that as it may, some organizations revealed that the implementation of APS applications is not as proactive as it should be especially in developing countries such as Nigeria. Channel members continue to decry the enormity of most manufacturers' inability to meet up with lead time as a means to actualize excellent customer services. This deplorable situation may be due to a lack of enough research that provides a proper understanding of the pivotal role of APS applications. Apparently, there exists a knowledge gap that needs to be filled through research. This study sought to contribute little to fill this gap by theoretically reviewing the several aspects of APS applications.

Theoretical Foundation

Management Theory: Management theorists have identified ICT applications as valuable resources that can improve efficiency and safety in supply chain and logistics management. Ayantoyinbo (2015) contends that the use of ICT in the freight industry can lead to substantial cost savings. Such technologies can improve business processes and interconnections with other trading partners operating in the supply chain. These systems allow the information exchange in real-time improving the ability to plan transport and logistics activities and the level of customer service. The result is that the competitive advantage of the freight industry increasingly depends on the ability to create value for customers through ICT since many value-adding activities are directly or indirectly dependent on ICT applications. Modern management theorists such as Mohd (2021) sees modern organizations as complex systems and underlies contingency approach and the use of modern techniques to solve organizational and human problem**.**

The Concept of Advanced Planning and Scheduling Applications

Advanced Planning and Scheduling (APS) application is a concept that has received growing attention within the last few years because of its enormous benefits to supply chain and logistics operations. Before we foray into this topic, it is imperative to define the primary words 'planning and scheduling'. Planning and scheduling are distinct but inseparable aspects of managing the success of any given project. Moylan (2002) posits that the process of planning primarily deals with selecting the appropriate policies and procedures in order to achieve the objectives of a project. Scheduling converts the project action plans for scope, time, cost, and quality into an operating timetable.

Having gotten a grasp of what planning and scheduling mean, we will immediately dive into the subject matter. There is no generally accepted definition of the term Advanced Planning and Scheduling (APS) applications. It is sometimes used interchangeably with Advanced Planning and Scheduling Systems (APS), and this will remain the case in this study.. According to Naden (2000), an APS application is a set of technologies, business processes, and performance metrics that enable manufacturing companies to compete more effectively in the global marketplace. The technologies involved are computer software and hardware that enable organizations to change the way they plan, schedule, forecast, distribute, and communicate with customers and suppliers. Linea (2012) opines that an APS application is a type of system that tracks costs based on the activities that are responsible for driving costs in the production of manufacturing goods. An APS allocates raw materials and production capacity optimally to balance demand and plant capacity. Implicit in this is that APS applications are techniques that deal with analysis and planning or logistics and manufacturing during short, intermediate, and long-term time periods.

The term APS system is rather ambiguous. Kilger and Wetterauer (2005) posit that most of APS systems are industry-specific and differ in many aspects including planning concepts, planning tasks, planning methods, plans' optimization procedures, and even in the used terminology. On the other hand, Lupeikiene, Dzemyda, Kiss, and Caplinskas (2014) explain that APS has a number of commonalities and forms a family of congenerous systems which is characterized by these commonalities. Grouping can be done at different levels: by common business objectives, by common problem domains, by a set of typical problems, and by a set of typical features.

An APS system is a software system designed to integrate with Enterprise Resources Planning (ERP) and Manufacturing Resources Planning (MRP) systems to enhance short-term production planning and scheduling (Bitepipe, 2012). The concept of advanced planning and scheduling was developed by the joint efforts of scientists and software developers as an answer to the challenges posed by the limitations of the classical ERP systems (Lupeikiene *et al*. 2014). From a product-oriented point of view, an APS system does not substitute but only supplement or extend existing ERP systems (Rohde, 2005). Implicit in this sense is that the ERP system handles basic activities

and transactions, such as customer orders, accounting, etc., whereas the APS system handles daily activities for analysis and decision support. It can be implemented as a subsystem of a particular ERP, as an add-on to a number of different ERPs, or as a stand-alone package that can be executed autonomously as well as in cooperation with a particular ERP.

From a supply chain perspective, An APS application is a system that suits like an umbrella over the entire chain, thus enabling it to extract real-time information from the chain, with which to calculate a feasible schedule, resulting in a fast, reliable response to the customer (VanEck, 2003). The Association for Operation Management (AOP) describes APS systems as any computer program that uses advanced mathematical algorithms or logic to perform optimization or simulation on finite capacity scheduling, sourcing, capital planning, resource planning, forecasting, demand management, and others. These techniques simultaneously consider a range of constraints and business rules to provide real-time planning and scheduling, decision support, available-to-promise, and capable-to-promise capabilities. APS often generates and evaluates multiple scenarios. Management then selects one scenario to use as the "official plan" (APICS, 2011).

Much has been written about APS applications and their impact on manufacturing companies. APS applications work in significant ways that make manufacturing operations seamless. It incorporates some form of computerized optimization, using one or more mathematical algorithms. Fleischmann, Meyr, and Wagner (2008) affirm that APS aims to support decision-making by identifying alternatives for future activities and by selecting good strategies or even the best ones while considering the decision maker's objectives and constraints in the company's environment. In manufacturing, APS applications provide a method of concurrent synchronization of material and capacity with customer orders. APS systems are not transactional systems. They prepare plans and schedules but then need to be linked to a transactional system like ERP to manage the execution of the plan or schedule. Goor *et al.* (2019) assert that advanced planning and scheduling applications cover the entire supply chain and use up-to-date information to calculate the schedules it generates. Such a system makes it possible to respond almost instantaneously to customer inquiries, though this is just one of its functions.

True, the primacy of APS applications cannot be emphasized. To begin with, Rudberg & Thulin (2009) identifies that APS applications support the master production scheduling process, lead to higher throughput at a lower total cost, result in higher service level with reduced total capacity and lower inventory, increase supply chain visibility and coordination, and more time-efficient planning and re-planning with fewer persons involved in the planning process. APS applications also bring about more proactive planning through the possibility to swiftly run a number of scenarios at very short computing times, help in better and more frequent communications between various functions within the company, and better integration between production and distribution planning leading to more efficient use of a scarce resource.

Dimensions of APS Applications

There are five main dimensions of APS Applications. They are demand planning, production planning, production scheduling, distribution planning, and transportation planning applications respectively (APICS, 2011).

Demand Planning Applications: In the first place, demand planning otherwise known as demand forecasting is the process of predicting what the demand for certain products will be in the future. It identifies what both current and future customers will want to buy and tells manufacturing facilities what they should actually produce (PlanetTogether, 2021). The demand planning and forecasting function uses both statistical and time-series mathematics to calculate a forecast based on sales history. A demand forecast is unconstrained because it considers only what customers want and not what can be produced (Goor *et al.* 2019). It is rational to say then that demand planning is an integral component of manufacturing operations that wish to properly

produce the correct amount of products without increasing inventory costs and creating excess waste.

In their report, Jason and Margot (2010) explain that Oracle Demand Planning is an example of a demand planning application. It is a web-based application that enables organizations to produce unconstrained forecasts for future demand and generate tactical, operational, and strategic business plans. SAP Integrated Business Planning is another example in this sense. According to G2 (2022), the largest and most trusted software marketplace, SAP responds to new market expectations with real-time supply chain planning capabilities and fulfills future demand profitably through supply chain management. Powered by in-memory computing technology within SAP HANA, this cloud-based solution combines capabilities for sales and operations; demand, response, and supply planning; and inventory optimization.

Production Planning Applications: Successful supply chain organizations have based much of their efficiency upon good production planning. Production planning is the process in which a manufacturing operation ensures that raw materials, staff, and other resources within the operation are prepared to create finished products according to a specified schedule (PlanetTogether, 2021). The production planning function of the APS works closely with sales to ensure that produced goods are sold to the right customers, at the right time, for the right cost, quantity, and quality. Stadtler (2005) affirms that production and sales planning aims at the efficient use of company capabilities and the realization of the foreseen demands in the medium-term planning horizon, by planning simultaneously the functions of production, purchasing, and distribution. PlanetTogether (2021) adds that a principal benefit of a production planning application is that it can serve as a guide for a company's production activities and establishes a sequence of activities that must be carried out to achieve a production target. Production planning can be challenging, as it must account for the availability of raw materials, resource capacity, and actual or forecasted demand.

In his evaluations, Khaleel (2022) lists MRPeasy and SAP S/4 HANA as some of the leading production planning applications in contemporary times. The MRPeasy gives more accurate lead times when generating quotes with numerous reporting tools. It also boosts machinery implementation and productivity with immediate reporting to check runtimes and applicable maintenance. SAP S/4 HANA permits users to organize every stage of their operations, from material requirements to inventory. Producers can promptly modify the information as they receive it from the business, supplier, or plant floor

Production Scheduling Applications: According to PlanetTogether (2021), production scheduling is the process of arranging, controlling, and optimizing work within a production process. The scheduling component builds from the demand and the production plan to generate a schedule that production is able to carry out. Goor *et al.* (2019) establish that based on detailed product attributes, work centre capabilities, and material flow, a schedule is a determined process that optimizes the sequence and routings of manufacturing orders on the shop floor. A fundamental point to recognize is that advanced production scheduling system benefits include inventory reduction, reduced product changeover time, reduced scheduling effort, and labour load leveling.

Some of the leading productions scheduling applications are DELMIAworks and Plex Systems. Khaleel (2022) posit that DELMIAworks establishes every resource and expense needed to fulfill manufacturing demands such as forecasts, sales orders dependents, current work orders, estimated on-hand balances, and transforming data into cohesive production plans with production scheduling traits. Whereas Plex Systems plan every stage of the MRP process with the production-scheduling attributes. This appliance allows manufacturers to estimate purchased and manufactured materials based on period and computed requirements, customer sales revenue, and manufacturing quantity.

Distribution Planning Applications: Distribution planning represents one of the most important activities in supply chain management and considers the availability of stocks and transports for generating the scheduling of deliveries (Safaei, Moattar-Husseini, Z.-Farahani, Jolai, & Ghodsypour, 2010). Distribution planning is the method that is utilized for planning orders within a supply chain. This component is based on a demand forecast to calculate the inventory requirements for various timeframes (PlanetTogether, 2021). It is beneficial to the entire supply chain process because it coordinates the demand for a future period with the on-hand inventory and the safety stock requirements for the period. Overall, this component carries out how much inventory of each material or part is needed to achieve high order-fulfillment status.
Koshulko (2022) affirms that Streamline is the world's leading Distribution Requirements Planning Software Platform for small to medium-sized and large enterprises. While other software usually simplifies calculations without colliding events realistically, Streamline Software creates a timeline with a one-day resolution and puts all schedules onto the timeline. Then Streamline executes the event sequence giving manufacturers the most accurate information about the company's inventory levels with one-day precision. Sometimes it's just a more precise method than replenishment formulas, but in many cases, it's the only way to accommodate the real-world supply chain complexity. SAP Integrated Business Planning, Kinaxis RapidResponse, and Logility Solutions are other great software for supply chain and logistics planning.

Transportation Planning Applications: Sousa, Camparotti, Guerrini, Silva, & Azzolini (2014) believe that transport planning considers short-term factors, such as routing or vehicle availability. It is defined by PlanetTogether (2021) as the planning and management processes required to transport people and goods throughout the supply chain. This process is a collaborative effort that looks to identify the transportation needs of a facility and assess the efficiency, cost, and design of the transportation model. Implicit in this is that it uses current freight rates to minimize shipping costs. A fundamental point according to (Goor *et al.* 2019) to recognize is that it can also optimize outbound and inbound material flow to minimize transportation costs or maximize utilization of the truck fleet. Consolidation of shipments into full truck loads and planning of transportation routes by sequencing the delivery/pickup locations are several of its other functions.
Examples of transportation planning applications include 3Gtms, E2open, and Descartes. 3Gtms is a Cloud-based provider of end-to-end Truckload, Less-than-truckload, and parcel capabilities for Omni channel shippers, e-commerce companies, 3PLs, and freight brokers. The solution performs order management, freight planning, carrier rating, execution, and settlement from a single screen for easier management of complex shipping. E2open plans, procures, executes, tracks, and settles shipments with e2open's transportation management system (TMS) for all modes and regions - domestic and international logistics for shippers, freight forwarders, carriers, and logistics service providers (LSPs). Descartes offers stand-alone TMS and managed TM services. Robust domestic and international capabilities for shippers and 3PLs supporting all freight modes (LaGore, 2022).

Theoretical Findings

From the theoretical accounts of several studies reviewed in this paper, it can be deduced that Advanced Planning and Scheduling (APS) applications are mostly in use by manufacturing firms in particular and the supply chain and logistics organizations in general. This may be due to the result-oriented nature of the Advanced Planning and Scheduling (APS) applications/systems. The study explored a lot of materials relating to the Advanced Planning and Scheduling (APS) applications in manufacturing firms, and supply chain management, the way Advanced Planning and Scheduling (APS) applications works, and the importance of Advanced Planning and Scheduling (APS) applications in shop floor realities.
The management theory was used to support the claims in this paper. The theory supported the use of ICT and modern techniques in supply chain operations. Owing to the emergence of

sophisticated customers who are demanding high-quality, tailored made products, and that most supply chain organizations are profit-driven and aim at fewer process inefficiencies and less product waste, this paper can serve as a guide that reinforces the need for organizations to deploy Advanced Planning and Scheduling (APS) applications. Hence it is safe to say that this paper has made some contributions to the literature on Advanced Planning and Scheduling (APS) applications by means of generating ideas that may either lead to further research or have policy implications for present and future supply chain business operations in Nigeria.

CONCLUSIONS

From this study, we, therefore conclude that Advanced Planning and Scheduling (APS) applications are a necessary cornerstone for competitive advantage. Despite the fact that some organizations are yet to deploy it or harness its usefulness, APS applications should be deployed by all organizations looking to attain sustainable growth. APS applications create optimized schedules that balance production efficiency and delivery performance, maximize throughput on bottleneck resources to increase revenue, synchronize supply with demand to reduce inventories, provide company-wide visibility to resource capacity, and enable scenario data-driven decision-making.

REFERENCES

Amier, A. & Ammar, A. (2010). The Utilization of Advanced Planning Scheduling (APS) at UK & Worldwide in the Construction Industry*. Proceedings of the 16th International Conference on Automation & Computing, University of Birmingham, Birmingham, UK. Retrieved from* https://www.academia.edu/342922/The_Utilisation_of_Advanced_Planning_Scheduling_APS_at_UK_and_Worldwide_in_the_Construction_Industry

Ayantoyinbo, B. B. (2015). Assessing the impact of information and communication technology (ICT) on the performance of freight distribution. *European Journal of Logistics, Purchasing, and Supply Chain Managemen*t, 3(4), 18-29

Blackstone Jr., J.H. (Ed.) (2010). *APICS Dictionary*, 13th ed. APICS the Association for Operations Management, Chicago, IL, USA.

Fleischmann, B., Meyr, H., Wagner, M. (2008). Advanced Planning. In: Stadtler, H., Kilger, C. (eds) *Supply Chain Management and Advanced Planning*. Springer, Berlin, Heidelberg. Doi:10.1007/978-3-540-74512-9_5

Goor, A.R. & Amstel, M.J. & Walther, P. V.A. (2019). *Advanced Planning and Scheduling (APS).* 11. 453-476. doi; 10.4324/9781003021841-20.

G2. (2022). *SAP Integrated Business Planning*. Retrieved from https://www.g2.com/products/sap-integrated-business-planning/reviews

Jason, L. & Margot, M. (2010, May). *Oracle Demand Planning Implementation and User's Guide*, Release 12.1 Part No. E13634-05. Retrieved from https://docs.oracle.com/cd/E18727_01/doc.121/e13634.pdf

Kilger, Ch., Wetterauer, U. (2005). The selection process. In: Stadtler, H., Kliger, Ch. (Eds.), *Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies*. 3rd ed. Springer, Berlin/Heidelberg: 303–316.

Khaleel, H. (2022). *Best Production Planning Software*. Retrieved from https://www.selecthub.com/enterprise-resource-planning/features-requirements-production-planning-software/

Khaleel, H. (2022). *The Best Production Scheduling Software for Manufacturing*. Retrieved from https://www.selecthub.com/manufacturing/production-scheduling-software/

Koshulko, A. (2022, October 23). *10 Best Distribution Requirements Planning Software for 2023*. Retrieved from https://gmdhsoftware.com/distribution-requirements-planning-software/

LaGore, R. (2022, November 28). *2023 Best Transportation Management System (TMS) Software Packages*. Retrieved from https://blog.intekfreight-logistics.com/best-transportation-management-software-tms

Linea, K. I. (2012). Advanced Planning and Scheduling (APS) Systems to Support Manufacturing Planning and Control Processes. (*Doctoral dissertation, Chalmers University of Technology*). https://publications.lib.chalmers.se/records/fulltext/162616/162616.pdf

Lupeikiene, A., Dzemyda, G., Kiss, F., & Caplinskas, A. (2014). Advanced Planning and Scheduling Systems: Modeling and Implementation Challenges. *Informatica*, 25(4), 581-616. doi:10.15388/Informatica.2014.31

Mohd, S. M. (Ed.). (2021). *Management Theory and Practice*. (1st ed.) Scripown Publications, Rohini: Delhi.

Moylan, W. A. (2002). *Planning and Scheduling: The Yin and Yang of Managing a Project*. Paper presented at Project Management Institute Annual Seminars & Symposium, San Antonio, TX. Newtown Square, PA: Project Management Institute.

Naden, J. (2000). "Have a successful APS implementation", *IIE Solutions*, 32(10),:10.

PlanetTogether (2021). *5 Components of Advanced Planning and Scheduling Software*. Retrieved from https://www.planettogether.com/blog/5-components-of-advanced-planning-and-scheduling-software, April 14

PlanetTogether (2021). *The Main Differences between Planning and Scheduling*. Retrieved from https://www.planettogether.com/blog/the-main-differences-within-planning-and-scheduling#:~:text=The%20main%20difference%20between%20planning,within%20operation%20and%20production%20scheduling. , May 24

Rudberg, M., & Thulin, J. (2009). Centralized supply chain master planning employing advanced planning systems. *Production Planning & Control*. 20:.158-167. DOI: 10.1080/09537280802705047.

Safaei, A. S., Moattar-Husseini, S.M., Z.-Farahani, R., Jolai, F., & Ghodsypour, S.H. (2010) Integrated multi-site production-distribution planning in supply chain by hybrid modeling. *International Journal of Production Research*, 48(14) :4043-4069. DOI: 10.1080/00207540902791777

Sousa, T., Camparotti, C., Guerrini, F., Silva, A., & Azzolini, W. (2014). An overview of the advanced planning and scheduling systems. *Independent Journal of Management & Production*. 5 :5i4.239.

Stadtler, H. (2005). Supply chain management and advanced planning - basics, overview, and challenges. *European Journal of Operational Research*, 163(3) :575-588.

VanEck, M. (2003). *Is Logistics Everything? A Research on the Usefulness of Advanced Planning and Scheduling Systems*. BMI paper, University of Amsterdam, Amsterdam.