Inventory automation practices and productivity: a study on steel manufacturing firms

Rashmi Ranjan Panigrahi

Institute of Business and Computer Studies,
Siksha O Anusandhan (Deemed to be University),
Bhubaneswar, Odisha, India
Email: rashmiranjanpanigrahi@soa.ac.in

Duryodhan Jena

Faculty of Management Science,
Siksha O Anusandhan (Deemed to be University),
Bhubaneswar, Odisha, India
Email: duryodhanjena@soa.ac.in

Padma Charan Mishra*

The Bisra Stone Lime Company Limited,
Birmitrapur, Sundargarh, Odisha, India
Email: pcmishra71@gmail.com
*Corresponding author

Abstract: The purpose of this study is to explore the relationship between inventory automation practices (IAP) and the productivity of steel manufacturing firms. The study also explores the mediation effect of knowledge of IAPs on the relationship between IAP and firms' productivity (FP). Study based on data, collected from 287-key officials of three manufacturing firms of Odisha, India using a structured questionnaire. SPSS and Amos software were used for data analysis. Data were processed through the test of validity and reliability and subsequently, structural equation modelling (SEM) was applied to test the hypotheses. The research findings revealed that IAP has a significant positive impact on the productivity of manufacturing firms. It is also found that knowledge of IAP is partially mediating the above relationship. It will add to the existing body of knowledge and further help practitioners to understand the importance and relationships of inventory automation practices in steel manufacturing firms.

Keywords: inventory management; steel manufacturing firms; inventory automation practices; firm productivity; structural equation modelling; India.

Reference to this paper should be made as follows: Panigrahi, R.R., Jena, D. and Mishra, P.C. (2022) 'Inventory automation practices and productivity: a study on steel manufacturing firms', *Int. J. Applied Systemic Studies*, Vol. 9, No. 3, pp.195–213.

Biographical notes: Rashmi Ranjan Panigrahi is a research scholar at the Institute of Business and Computer Studies (IBCS), Siksha 'O'Anusandhan, Bhubaneswar, Odisha, India. He has eight years of academic as well as administrative experience and one year of corporate experience. He teaches different finance and core papers of master degree students.

Duryodhan Jena has 17 years of academic experience and teaches specialisation papers of operation management, statistics, research methods for managers, quantitative techniques, QTM, material management, world class manufacturing.

Padma Charan Mishra is an executive of a CPSE, Government of India since 2002. He is an independent researcher with 8-year experience. He has published two books and 16 research articles in Scopus and WoS indexed journals. He is a certified reviewer of Springer, an Editor in *International Journal of Management and Leadership Studies* and reviews research article for many emerging source citation, science citation and Scopus indexed journals.

1 Introduction

Automated inventory management practices are considered as key battle ground to manage business competitiveness in long term. In modern manufacturing, firm factory automation is one of the economic justifications for trader and business houses. Decision support system factory automation (DSSFA) is highly beneficial weapon towards adoption of robotic system of manufacturing units. It provides flexibility in operation as well as smoothness production process (Son, 1991). Inventory automation practices have been in trend for sophistication and precision through development of modern computerised systems. Perpetual inventory systems is an example which was introduced for tracking of goods, checking the update of inventory quantity and its availability for smooth functioning of production units (Caudell, 2018).

Every firm's inventory policies have an aim to hold adequate amount of finished stocks to meet market demand, reduce the cost of holding and it leads to use of computerised inventory management techniques (Samuel and Ondiek, 2014). Above all, automation practices lead to reduction in operational cost and provide better customer services. Samuel and Ondiek (2014) also suggested for effective management of inventory which need adoption of automated/computerised inventory management operation. Details and systematic record through automated system provides opportunity to manufacturing firms to cope with market demand (Liu and Ridgway, 1995). Implementation of Inventory automation practices would reduce the time of stock verification, tracking of goods, helps to generate quick report for respective department as per their demanded order. For effective use of inventory management practices, firms should have qualified and knowledgeable managers and staff (Ahmad and Zabri, 2018). Inventory management also improves firms' productivity through *production scheduling*, *production*, and *delivery lead time* (Jonsson and Mattsson, 2008).

In business most often managers have gone through difficult decision like trade off in between sales volume and cost, which has direct impact on firm's performance (Koumanakos, 2008). Inventory control techniques play a significant role towards

increasing the firms' productivity through the help of material management function (Panigrahi and Jena, 2020).

The impact of Inventory automation practices on company productivity is investigated in the context of a theoretical model, i.e., the resource-based approach (RBV) (Barney, 2001). As per RBV theory, the resources and capabilities of firm control measures both have an impact on maintaining a competitive advantage. The importance of credible resources to a firm's competitiveness and long-term survival was further highlighted by resource-based approaches (Adnan et al., 2018; Augier and Teece, 2018). RBV proposed lots of strategic intent to accomplish the firm's desired performance (Hitt et al., 2015; Kamboj et al., 2015). From the past literature of Cannon (2008), Koumanakos (2008), Boute et al. (2007), Ogbo and Ukpere (2014), Kolias et al. (2011) and Panigrahi (2013), it was observed that substantial work done in the area of inventory management practices with relation to firms' performance. Except robust techniques on inventory management practices and its impact on performance, very negligible empirical evidence was observed regarding inventory automation practices (IAP) in manufacturing firms. An attempt has been made to identify the role of automated inventory management practices towards steel manufacturing firm's productivity. This article examines the various IAPs used throughout steel manufacturing firms to improve productivity and evaluates the impact of IAP knowledge in the relationship between IAP and firm productivity. Wireless-based application in a manufacturing industry has become popular in form of RFID, barcode, and electronic data interchange (EDI), etc. These application-based practices are most reliable, responsive and sophisticated in practice used in inventory management to have competitive advantages (Ranjan et al., 2020). Good use of EDI are consider much better equipment used by firms as compared by outdated methods of inventory control (Rushton et al., 2014). To address practical issues related to storage and order restriction, every organisation has to give its attention for management of inventory in a firms or business units. The paper applied optimal replenishment techniques for effective management of inventory. The result of this articles depicts capacity restriction can help to maintain the stock as per its priorities. Moderate storage capacity and heuristic have positive impact on optimal policy system of the firm (Sharma et al., 2020). Information systems' accuracy from IAP brings efficient production facility for manufacturing firms. So, it is worthwhile to discuss the role of inventory automation in steel manufacturing firms for improving firms' productivity.

2 Literature review and hypothesis

2.1 Inventory management

Inventory is considered as valuable assets for any organisation and it has significant contribution in improvement in firms' performances. Holding of lowest and highest inventory has significant effect in increase and decrease in firm's performances. Zero inventory concepts do not hold well in a manufacturing firm (Obermaier and Donhauser, 2012). Information related to this need to be more accurate, reliable and consistence. Inventory management helps to reduce cost of holding goods, faster product delivery to customer, etc. (David, 1996). IM systems and inventory control provides smooth flow of raw material, efficient utilisation of people, machinery, equipment and right communication with clients (Wolcott, 2000). Inventory management deals with

maximisation of customer service, maximising investment in inventory, maximising efficiency in purchase and production and maximising return on investment (David, 1996). IM have deals with proper maintenance of stock as per quantity required, so that it will helps in minimising the ordering and handling cost of inventory (Obura, 2015).

2.2 Inventory automation practices and firms productivity

In this competitive business world, every manufacturing organisation put more emphasis on inventory management. In 21st century with the advent of technology, inventory management became easier for every organisation. According to Raviv and Kolka (2013) most accepted techniques of IM are radio frequency identification (RFID), barcode technology, distribution requirement planning (DRP), automated inventory tracking systems (AITS), just-in-time (JIT), vendor managed inventory (VMI) systems. Materials movements inside the manufacturing firms as per production requirement has controlled and administered through MRP techniques (Sople, 2010). Barcode helps to accelerate the free flow of goods along with information inside the business operation. Electronic point of sales (EPOS) use barcode for different activity of products such as scanning, verification, tagging, transaction information, generate sales report, communicate the warehouse department for next delivery, etc. (Lysons and Farrington, 2006). In case of warehouse management, smart warehouse automation (SWA) is considering as one of the most effective techniques. To address the issues of suppliers and distributor looking at market demand, automation supposed to be the best practice as compared to tradition warehouse management practices. As the number of orders placed by supplier is increased by looking at customer demand and varieties, so traditional warehouse systems were failed to satisfy the customer requirement; He et al. (2018) suggest management must invest on inventory automation techniques in management of warehouse. Manufacturing firms use barcode for product labelling, for better product delivery system, cost effective process and quick accessibility of information of inventory status in the production units.

RFID bringing down the IM efficiency but contribution towards organisation profitability is yet to achieve. Effects of RFID technology on the efficiency and profitability in retail unit in supply chains process, this practice gives better result in tested companies in the USA (Shin and Eksioglu, 2014). Another technique MRP has also having impact on material planning system in a manufacturing unit. Paper suggests garment industry should use raw material planning order systems. Raw materials should be kept 3-days in anticipation to meet with unexpected market demand. This study suggests it can be extended to warehouse management systems (Hasanati et al., 2019). Computerised inventory management is contributing for successes of a manufacturing industry. Owoeye et al. (2014) developed Manlnvent software to address two major issues of manufacturing firm i.e. when to purchase and how to purchase. This application has multi-level approach and worked in adverse environment. Inventory management practices have significant contribution in operational performance of selected companies in Nigeria. It focuses on computerised IM and has an impact on productivity. Study applies simple regression to test above relationship and it concluded the computerised inventory management has positive impact on organisational productivity (Akinlabi, 2017). Inventory and business strategy have impact on firm's profitability as well as firm's performances. If firms properly maintain inventory then any manipulation in sales give rise to future profitability and firms' position. Due to minimisation of inventory

holding cost and obsolescence is having indirect effect on firms' performances (Yi et al., 2019).

IMP also has its impact on the operational performances of departmental store. The major factors are studied viz. availability of stock, inventory accuracy, optimum capacity utilisation and lean inventory management. SEM is applied to study the relation of IMP on store performances and it is clearly mentioned that availability of stock, inventory accuracy, lean inventory management have positive effect on operational performance, whereas optimum capacity utilisation does not have that much effective towards performances (Khan and Siddiqui, 2019). Based on the above literature the 1st hypothesis is introduced.

H1 IAPs have significant impact on FP.

2.3 Inventory automation practices and knowledge of IAPs

In a manufacturing firm manager should have knowledge regarding inventory management practices. Inventory automation techniques need conceptual clarity before it is implemented in a manufacturing industry towards enhancement of firms' productivity. Knowledge management had contributed for better utilisation of resources to increase organisational productivity as well as to get competitive advantages (Fugate et al., 2009). Knowledge is recognised as a strategic resource unit in supply chains. Article highlights the contribution of knowledge in SCM. It is based on mixed method research, which highlights justification through Quant. Approach to support for theorised relations among knowledge elements, SCS, and performance. With the developed analysis of MMR, paper concludes with knowledge is 100% matches with the strategy approach (Hult et al., 2006).

Knowledge inventory management has impact on pricing policies of service industry. Wu et al. (2008) put emphasis on identifying the knowledge inventory problems with respect to option pricing model in insurance. Finding of this paper indicates actuarial model used to analyse the problems based on different condition. It was concluded with the statement larger the value of actuarial then longer will have to set time period, which makes more profit. This conceptual background must utilise in the real-life problems in different situation.

The role of knowledge management has significant contribution in supply chain management. Knowledge management viewed as leverage mechanism in among SMC. Pérez-Salazar et al. (2017) highlighted reinforcement of knowledge management has an impact on the product development, enhancement of inter and intra supply chain, SC strategy.

The role of knowledge management has an impact on innovative supply chain design. The article is based on exploratory research on contribution of KM to SCM and in SC design. Knowledge management makes very strong impact on SCM through process of KM (knowledge creation, sharing, collaboration, and integration), KM to the complex situation of SCM (Gloet and Samson, 2018).

According to Ahmad and Zabri (2018) in between the relationship of inventory management practices and performance, role of knowledge of inventory management play a mediating role. Article wants to test the knowledge of IMPs in between IMPs and Enterprises performance. The above relationship is tested through factor analysis and structural equation model techniques to measure the above complex relation. The study

confirms that IMPs have positive impact on firm's performance, whereas knowledge of IMPs has partially played the role of mediating in between those two variables. As per the article the above relation can be tested in large manufacturing units. In an organisation, sufficient training must be provided to officials and employees for understanding the inventory control systems (Waters, 2003). By going through above literatures, second hypothesis is proposed.

H2 IAPs have significant relationship with knowledge of IAPs.

2.4 Knowledge of IAPs and FP

Human practices play significant role in the contribution on the sophisticated inventory management practices (Ahmad and Zabri, 2016). Knowledge inefficiency and lack of qualified working professional may lead to finding problems calculation, valuation of stocks in stores and in operation, which can create adverse condition in inventory management (Kotzab and Teller, 2005). Ahmad and Zabri (2018) study finds the mediating effect of inventory management knowledge (IMK) on relationship between IMP and retail enterprises performance. This paper identifies that though knowledge plays partial mediating role in small sector in between IMP and enterprises performances but in large manufacturing firms it has contributed to a large extent. Inventory management has impact on organisational efficiencies towards reducing the overall cost of firm. Contribution of scientific management has significantly reduced inventory cost. EOQ, inventory cycle and reorder level techniques are important strategic techniques for manufacturing firm. The result reveals that if company wants to minimise the inventory cost, then on a continuous basis it has to adopt and monitor the scientific inventory management policies (Inegbedion et al., 2019). IM strategies are being frequently used by SME's for improving the firm performances in manufacturing unit (Bahri et al., 2011). The techniques used in this study were JIT and lean management for optimisation of resources. The paper made an attempt to study capacity optimisation and costing mathematical model to address the management issue. It is also highlighted that lack of inventory management knowledge is a big challenge for manufacturing firm in achieving constant improvement in firms' productivity (Muchaendepi et al., 2019). Kolawole et al. (2019) undertook study on International Breweries, Nigeria and explained inventory management has positive impact on increase in profitability of manufacturing unit. That paper attempted using SLR and correlation to study the above said relationship and presented that for increasing the profitability of firms, there should have provision and scope for adoption of new and advanced inventory management for proper utilisation inventory items. By looking at competitive market condition, inventory management for firm is considered a major factor for survival. Effect of IMP has on performance of the commercial state corporation. Mulandi and Ismail (2019) strongly argued that firm's efficiency and effectiveness has mainly affected by inventory management. Total 60–70% fund of manufacturing firm's investment is in inventory and stock management activities. The contribution of JIT and MRP as scientific inventory management practices positively contributed towards performances of commercial State Corporation in the country, Kenya (Mulandi and Ismail, 2019). By going through extant literatures, we try to make an attempt to test KIAP with FP.

H3 Knowledge of IAPs has significant relationship with FP.

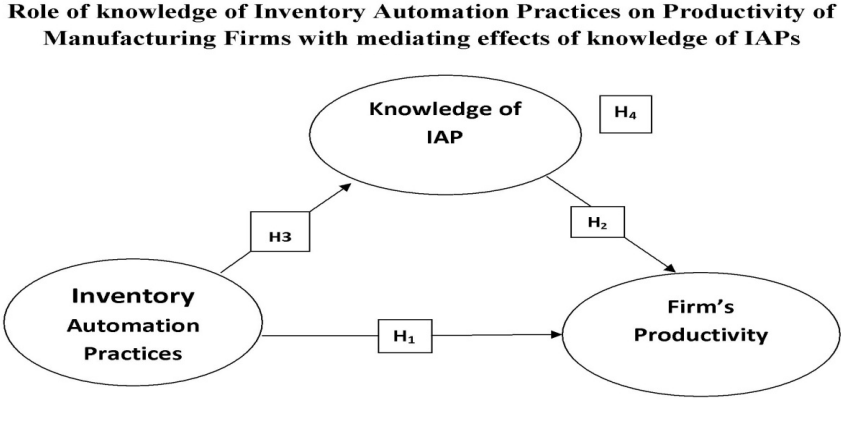
2.5 Relationship between inventory automation practices and productivity with mediation effect of Knowledge of IAP

It is found from the extant literature that inventory management links with the firm's productivity in the presence of knowledge of IAP. The officials must have competent enough to properly understand the process of systems adoption and implementation of Inventory automation practices. Without understanding how, where and when to apply the IAPs, it has no meaning to work with automation process in the area of inventory management. De Vries (2011) explained in his article, proper allocation of responsibility along with decision-making process, innervations of human factor can be dealt without presence of which analysis of problems; inventory system design etc. couldn't be possible to operate. Officials as well as workers of IMPs or IAPs must require appropriate training and development programme before assigning any responsibilities or assignment with respect to inventory automation practices. Lack of knowledge of inventory management certainly leads to poor performance (Kotzab and Teller, 2005). As per Ahmad and Zabri (2016), knowledge of inventory and adequate training programme helps us to understand systematic managerial practices and leads to high performance of an organisation. Ahmad and Zabri (2018) also highlighted knowledge of IMPs has significant role in relationship between IMPS and retailing enterprises performance. ABC is one of the important scientific IMP, which has significant impact on efficiency of retail outlets. The categorisation techniques of IMP on proper management of stock are as per consumption rate. The factors under ABC analysis which have significant contribution are consumption rate, carrying cost and replenishment of product lead time. Study suggests that since it is technology-based practices, proper training must be given to the worker for better result. KIPM is one of the major aspects and must be looked into by management before discharging their duties (Jayakumaran et al., 2020). By going through literature, we proposed the knowledge of IAPs play mediating role in between inventory automation practices and firms performances.

H4 Mediating role of knowledge of IAPs in between IAPs and firms productivity.

The proposed model of our study is as shown in Figure 1.

Figure 1 Conceptual framework



3 Methodological foundation

Study is based on structural equation modelling (SEM) for testing the above hypothesis. SEM normally used to measure two components; one is reducing observed variable to make them latent factors and second the SE model, helps to identify the relationship among above latent factors (The University of Texas, 2012). This research focuses on steel manufacturing industry in the state of Odisha, India. Data has been collected through structured questionnaire by the use of purposive sampling (Guarte and Barrios, 2006, Karmel and Jain, 1987; Tongco, 2007) techniques from 287-respondents (Creswell, 2013); less than 50 (Adler and Adler, 2012); between 20 to 50 (Bryant and Yarnold, 1995); minimum 100 samples from three manufacturing industries (SAIL, Jindal Steel and Rashmi Steel) from the Indian state of Odisha. Pilot test were conducted to measure the validity and reliability of the data. Cronbach's alpha values were higher than 0.81 (more than 0.5 is reliable; Nunnally, 1978) which indicate variables found highly reliable for the study. The respondent are key officials of the manufacturing firms, i.e., purchase manager, operation manager, production manager, warehouse manager, and store in charge, etc. A five-point Likert (Likert, 1932) scale (where 1 – not at all effective, 2 – not effective, 3 – somewhat at, 4 – effective, 5 – very effective) is used in the instrument to collect the data with respect to IAPs adopted by manufacturing industries for improvement in productivity.

4 Factor analysis

We have conducted principal component analysis (PCA) with rotation of Varimax on 28-items. On the help of SPSS, we have confirmed principal items which contributed RFID practices, MRP practices, and barcode practices. Due to low factor loading of below than 0.65, 4 - items are removed out of eight items of RFID practices, similarly four items are removed out of ten items of materials requirements planning practices, six items are removed out of ten items of barcode practices. So total 14 items were selected under three inventory automation practices categories which have factor loading more than 0.65 (should be more than 0.5) (Hair et al., 2003; Field, 2013).

In case of firms productivity also we have selected seven items out of 15 items under three heads generating sales revenue, increasing output with minimum cost of production and optimum utilisation of capital.

5 Analysis and discussion

This section deals with results of data which were collected from 287 respondents using descriptive statistics techniques and presented the structural equation model. This section deals with subsections: Subsection 5.2 – correlation analysis of IAP and FP; Subsection 5.3 – deals with mediating effect of knowledge of IAP on IAP and firms productivity.

Table 1 Factor analysis by using PCA of IAP and FP

Variables	*Component 1*	*Component 2*
RFID practices 1	0.953	
RFID practices 4	0.938	
RFID practices 7	0.929	
RFID practices 5	0.919	
MRP practices 3	0.911	
MRP practices 6	0.906	
MRP practices 5	0.889	
MRP Practices 2	0.88	
MRP practices 10	0.873	
MRP practices 8	0.778	
Bar coding practices 9	0.761	
Bar coding practices 10	0.754	
Bar coding practices 4	0.736	
Bar coding practices 5	0.72	
Sales revenue 1		0.889
Sales revenue 2		0.856
Increase output 1		0.836
Increase output 4		0.821
Optimum utilisation of capital 1		0.811
Optimum utilisation of capital 3		0.789
Optimum utilisation of capital 4		0.697

Note: Rotation converged in two iterations.

Source: Authors' computation

5.1 Descriptive statistics

Under this section we discuss about inventory automation practices, which were measured by using scale of 14-items under three main component (radio frequency identification practices: four items; material requirement planning practices: six items and barcode practices: four items) and firms productivity were measured scale of seven items under three main components (enhancing sales revenue, increasing output, optimum utilisation capital). Most frequent inventory automation practices used by RFID practices – 3.322 (mean), followed by barcode (3.19) and MRP (3.17). In firms productivity all three components contributed almost equal weights, SR (3.16), increasing output (3.165) and optimum utilisation of capital (3.163). So, it is considered to be at good level as its average mean score is 3.23.

Table 2 Descriptive statistics of inventory automation practices and firms productivity

Variable	*Minimum*	*Maximum*	*Mean*	*Standard deviation*	*Skewness*	*Kurtosis*
RFID-1	1	5	3.17	1.234	–0.040	–1.243
RFID-4	1	5	3.41	1.213	–0.228	–1.172
RFID-5	1	5	3.52	1.263	–0.267	–1.401
RFID-7	1	5	3.19	1.279	–0.097	–1.351
MRP-2	1	5	3.21	1.229	–0.076	–1.282
MRP-3	1	5	3.22	1.310	0.045	–1.501
MRP-5	1	5	3.17	1.241	–0.071	–1.303
MRP-6	1	5	3.23	1.312	0.028	–1.510
MRP-8	1	5	3.20	1.254	–0.101	–1.329
MRP-10	1	5	3.17	1.234	–0.067	–1.273
BC-4	1	5	3.17	1.241	–0.071	–1.303
BC-5	1	5	3.23	1.312	0.028	–1.510
BC-9	1	5	3.21	1.229	–0.076	–1.282
BC-10	1	5	3.15	1.241	–0.049	–1.335
SR-1	1	5	3.11	1.235	0.008	–1.250
SR-2	1	5	3.21	1.229	–0.076	–1.282
COP-1	1	5	3.13	1.263	–0.026	–1.345
COP-4	1	5	3.20	1.220	–0.081	–1.271
OUC-1	1	5	3.11	1.235	0.008	–1.250
OUC-3	1	5	3.19	1.239	–0.076	–1.262
OUC-4	1	5	3.19	1.245	–0.106	–1.319

Source: Authors' computation

Skewness less than -1 and greater than 1 is highly skewed. Hence, all the six factors fall under the categories of highly skewed which shows data are normally distributed (Games, 1984). Acceptance criteria range for kurtosis is –2 to 2 (George and Mallery, 2016; Gravetter and Wallnau, 2014), accordingly all the data are under acceptable range. It represents data are normally distributed.

5.2 Test of correlation between factors of IAP and FP

This section deals with correlation between the factors of inventory automation practices with the firm's productivity. This analysis reveals that the sub-component of inventory automation practices have significant and positive relationship with firms productivity. This study strongly believes that IAP has strong relationship with firms' productivity with correlation value of 0.939. Large manufacturing are much more interested in implementation of automation practices by replacing manual management systems practices which have impact on performances (Atieh et al., 2016).

Table 3 Correlation analysis between the factors of IAP and FP

Var.	*RFID practices (RFP)*	*MRP practices (MP)*	*Bar-coding practices (BCP)*	*Inventory automation practices (IAP)*	*Firms productivity (FP)*
RFP	1	0.822**	0.928**	0.953**	0.900**
MP		1	0.885**	0.944**	0.872**
BCP			1	0.979**	0.928**
IAP				1	0.939**
FP					1

Note: **Correlation is significant at the 0.01 level (2-tailed).

Source: Authors' computation

5.3 Mediating effect of knowledge of inventory automation practices on IAP and FP

Structural equation model was run with the help of AMOS to check the effect of IAPs on FP and mediating effect of inventory automation knowledge on relationship between IAPs and FP. The confirmatory analysis was conducted to check the appropriate of measurement scale and construct of measurement model in accordance with existing literature. Table-4 highlights the composite reliability for the construct used in the model (Inventory Automation Practices, Firms Productivity and Knowledge of IAP); all are above the thresholds limit 0.70 (Fornell and Larcker, 1981), which suggest a high internal consistency / reliability among the construct. Along with CR, we have also checked the convergent validity through Factor loading and Average Variances Extracted (AVE), it should be greater than 0.05 (Fornell and Larcker, 1981) as an acceptance criterion. In our study all AVE value and almost all Factor loading values are greater than 0.75. So construct are high loading and with AVE above 0.80 shows high convergent validity. It suggests that items have enough capacity to explain the variance in the construct (Table 4).

5.3.1 Composite reliability coefficient

Table 4 Composite reliability coefficient of factors of IAP, FP and KIAP

Measured variables	*Constructs*	*Factor loading (l)*	*Squared factor loading*	*Error*	*Average variances extracted (AVE)*	*Composite/ construct reliability (CR)*
RFID Practices 1	RFID practices	0.953	0.91	0.09	0.77	0.93
RFID Practices4		0.929	0.86	0.14		
RFID Practices 7		0.849	0.72	0.28		
RFID Practices 5		0.757	0.57	0.43		
SUM of RFID		3.488	3.07	0.93		

Table 4 Composite reliability coefficient of factors of IAP, FP and KIAP (continued)

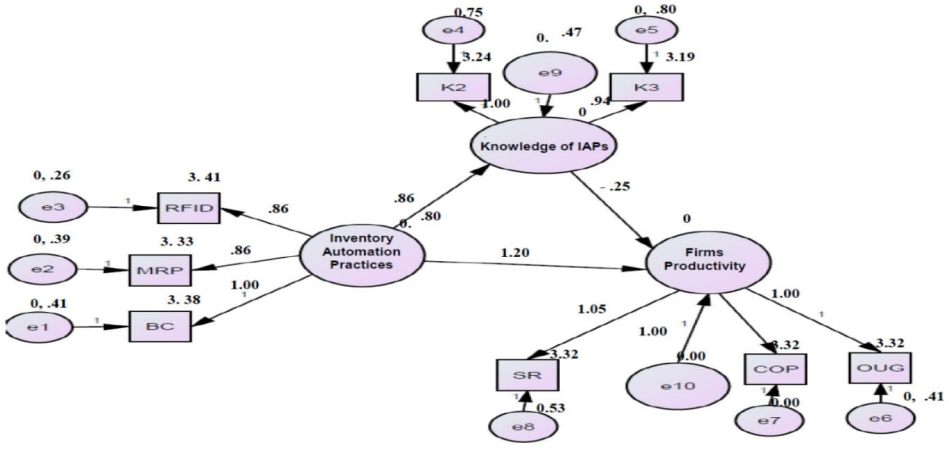
Measured variables	*Constructs*	*Factor loading (l)*	*Squared factor loading*	*Error*	*Average variances extracted (AVE)*	*Composite/ construct reliability (CR)*
MRP Practices 3	MRP practices	0.938	0.88	0.12	0.72	0.94
MRP Practices 6		0.851	0.72	0.28		
MRP Practices 5		0.688	0.47	0.53		
MRP Practices 2		0.657	0.43	0.57		
MRP Practices 10		0.957	0.92	0.08		
MRP Practices 8		0.953	0.91	0.09		
SUM of MRP practices		5.044	4.33	1.67		
Bar-coding practices 9	Bar-coding practices	0.924	0.85	0.15	0.71	0.91
Bar-coding practices 10		0.844	0.71	0.29		
Bar-coding practices 4		0.83	0.69	0.31		
Bar-coding practices 5		0.761	0.58	0.42		
SUM of bar-coding practices		3.359	2.83	1.17		
Sales revenue 1	SR	0.950	0.9	0.10	0.89	0.94
Sales revenue 2		0.939	0.88	0.12		
SUM of SR		1.889	1.78	0.22		
Increase output 1	IO	0.931	0.87	0.13	0.85	0.92
Increase output 4		0.911	0.83	0.17		
SUM of IO		1.842	1.7	0.30		
Optimum utilisation capital 1	OUC	0.951	0.91	0.10	0.85	0.94
Optimum utilisation capital 3		0.942	0.89	0.10		
Optimum utilisation capital 4		0.863	0.74	0.26		
SUM of OUC		2.756	2.54	0.46		
KIAP 3	KIAP	0.83	0.69	0.31	0.69	0.82
KIAP 4		0.83	0.69	0.31		
SUM of KIAP		1.66	1.38	0.62		

5.4 SEM model (standardised path coefficients between the construct:

The Proposed model has checked on the basis of model fit in the process of model fitting we have found out CMIN/DF (minimum discrepancy/degree of freedom) ratio used to measure fit of model (recommended value less than 3.0), structural modal value 1.964 (it is accepted because modal value is less than 3). Likewise, goodness of fit Index used as standardised fit index (Jöreskog and Sörbom, 1981) (GFI and AGFI) (recommended value above 0.90), our structural modal value is 0.920 and 0.901 which is above accepted value. Subsequently, normed fit index (NFI) (Bentler and Bonett, 1980) and relative fit index (RFI) (Hu and Bentler, 1999), comparative fit index (CFI) (Hu and Bentler, 1999), Tucker-Lewis index (TLI) (Tucker and Lewis, 1973), recommended value above 0.90 for NFI, CFI, RFI, TLI, modal values are above the limit such as 0.940, 0.968, 0.903, 0.968

root mean square error of approximation (RMSEA) (Hu and Bentler, 1999) recommended value above 0.06; modal value for the same is 0.051. All model fitness is achieved as per recommended values proposed by literature. Value of coefficient for determining R-square was 0.084, shows standardised coefficient in between the model constructs. It shows the influence of exogenous variable in estimating endogenous variable is 84%. Above mentioned fit indices are presented in Table 5.

Figure 2 Standardised path coefficients between the constructs (see online version for colours)



Source: Author's computation IBM SPSS Amos-20

Table 5 Fit indices for structural equation model

Fit indices	*Recommended values*	*Structural modal values*
P-values	0.065	0.084
CMIN/DF	<3.0 (less than 3)	1.964
GFI	>0.90 (above than 0.90)	0.92
AGFI	>0.90	0.901
NFI	>0.90	0.94
CFI	>0.90	0.968
TLI	>0.90	0.968
RFI	>0.90	0.903
RMSEA	>0.06	0.051

Source: Authors' computation

5.5 Path analysis of SEM

In Path analysis we found direct relationship between IAP and FP: 1.196, but after intervention of knowledge of IAP, value of path coefficient is 0.860 (KIAP-IAP) and FP-KIAP is less pass coefficient –0.651. Our findings show that relation in between IAP and FP which is partially mediating by knowledge of IAPs (Ahmad and Zabri, 2018).

Table 6 Path analysis of SEM

Var.	*Path*	*Var.*	*Estimate*	*S.E.*	*C.R.*	*P*	*Results*
KIAP	←	IAP	0.860	0.138	6.240	***	Accepted
FP	←	KIAP	0.651	0.145	4.650	***	Accepted
FP	←	IAP	1.196	0.186	6.440	***	Accepted
BC	←	IAP	1.000				Accepted
MRP	←	IAP	0.936	0.095	9.842	***	Accepted
RFID	←	IAP	0.860	0.082	10.437	***	Accepted
K2	←	KIAP	1.000				Accepted
K3	←	KIAP	0.936	0.155	6.039	***	Accepted
OUC	←	FP	1.000				Accepted
COP	←	FP	1.001	0.109	9.227	***	Accepted
SR	←	FP	1.052	0.108	9.767	***	Accepted

Source: Authors' computation

6 Conclusions

This study investigates the effect of KIAP on AIP and FP dimension like sales revenue, increase output, and utilisation capital in a manufacturing firm. Inventory automation practices like RFID and MRP and barcode practices dimension have used to measure the effect on firm's productivity. Further in the investigation of mediation effect of KIAP in between AIP and FP, paper used two major dimension Inventory knowledge Improved worker efficiency and productivity and training on recent IMP. It will help to check the effect on both IAP and FP.

The result of this article reveals that inventory automation practices (IAP) has significant effect on firms productivity dimensions of sales revenue and utilisation capital. Whereas study reveals that knowledge of IAP is partially mediating effect in between IAP and FP. Barcode practices does not show that much of significant effect on firm's productivity as compared to other two-dimensional practices.

According to the study's findings, it is in line with previous research on IA. The current research shows that inventory automation is the most important aspect to handle continuous production, low production costs, and rotation as the most common inventory control technique. RFID, VMI, and MRP are highly ranked management systems utilised throughout manufacturing; according to the study's findings it is in line with previous research on IA (Patel et al., 2015; Singh, 2020) as well as supporting the hypothesis that automation and KIAP have a significant impact on firms' productivity in an industry. A recent study diverted from an earlier study (Khan and Siddiqui, 2019), and as per the hypothesis, findings reveal that, in between IAP and FP, KIAP play partially mediation effect. This study supports the earlier findings (Ahmad and Zabri, 2018).This study contributed to a greater knowledge of inventory control in a large business scenario. The exploration of the benefits of inventory management puts a huge strain on several sections of the production function (Taticchi et al., 2010). Companies must choose either to use a single main inventory control approach or a combination of techniques to satisfy their demands and maximise their value. Otundo et al. (2015) and Tavana et al. (2017)

emphasised that inventory could be carried out effectively by setting up an efficient business plan, inventory planning, developing relationships with its suppliers, establishing a realistic inventory turnover objective, determining the holding cost of inventory, and having good mentoring to key employees in understanding the inventory control system.

6.1 Limitation and future scope

This study contains shortcomings. As a measuring instrument, a questionnaire was utilised; however, the items considered within the measurement criteria are not standardised. They are taken from previous research and tested for validity before use. The research might be expanded to look at the role of operational performance as a moderator in the relationship between IMP and business performance. It must have been revealed that no research was done in Indian steel manufacturing firms concerning inventory management effectiveness and industrial agglomeration. As a result, further research may focus on inventory management and industrial agglomeration in steel manufacturing enterprises. All above-mentioned potential research directions remain open to investigation in coming times as a result of in tense competition between Indian steel manufacturing firms and world steel manufacturers. In the future research can focuses on subjective measurement that can be used in a variety of industries, including retail and health care. Due to the limited consistency of the measuring scale, subjective evaluation may increase measurement error. Any measuring instruments which provide accurate results should be employed in future research. It is believed that objective measurement would provide precise information for accurate assessment.

References

Adler, P.A. and Adler, P. (2012) 'Keynote address tales from the field: reflections on four decades of ethnography', *Qualitative Sociology Review*, Vol. 8, No. 1 [online] http://www.qualitativesociologyreview.org/ENG/Volume21/QSR_8_1_Adler_Adler.pdf (accessed 10 January 2021).

Adnan, M., Abdulhamid, T. and Sohail, B. (2018) 'Predicting firm performance through resource based framework', *European Journal of Business and Management*, Vol. 10, No. 1, pp.31–40.

Ahmad, K. and Zabri, S.M. (2016) 'Inventory management practices among Malaysian micro retailing enterprises', *Journal of Business and Retail Management Research*, Vol. 11, No. 1, pp.103–115 [online] https://pdfs.semanticscholar.org/2508/05c830ab567ea0963767e7b252bc0399f1a1.pdf.

Ahmad, K. and Zabri, S.M. (2018) 'The mediating effect of knowledge of inventory management in the relationship between inventory management practices and performance: the case of micro retailing enterprises', *Journal of Business & Retail Management Research*, Vol. 12, No. 2, doi:10.24052/jbrmr/v12is02/tmeokoimitrbimpaptcomre.

Akinlabi, B.H. (2017) *Inventory Management Practices and Operational Performance of Selected Flour Mills Companies in Nigeria*, Doctoral dissertation, Babcock University [online] https://www.babcock.edu.ng/oer/oer/project_theses/college_of_postgraduate_studies/BUSINESS_ADMIN/INVENTORY%20MANAGEMENT%20PRACTICES%20AND%20OPERATIONAL%20PERFORMANCE%20OF%20SELECTED%20FLOUR%20MILLS%20COMPANIES%20IN%20NIGERIA.pdf (accessed 10 October 2020).

Atieh, A.M., Kaylani, H., Al-abdallat Yousef, Qaderi, A., Ghoul, L., Jaradat, L. and Hdairis, I. (2016) 'Performance improvement of inventory management system processes by an automated warehouse management system', *Procedia CIRP*, Vol. 41, pp.568–572, doi:10.1016/j.procir.2015.12.122.

Augier, M. and Teece, D. (Eds.) (2018) *The Palgrave Encyclopedia of Strategic Management*, Palgrave Macmillan, London [online] htpps://doi.org/10.1057/978-1-349-94848-2_703-1.

Bahri, M., St-Pierre, J. and Sakka, O. (2011) 'Economic value added: a useful tool for SME performance management', *International Journal of Productivity and Performance Management*, Vol. 60, No. 6, pp.603–621, doi:10.1108/17410401111150779.

Barney, J.B. (2001) 'Is the resource-based 'view' a useful perspective for strategic management research? Yes', *The Academy of Management Review*, Vol. 26, No. 1, pp.41–56, doi:10.2307/259393.

Bentler, P.M. and Bonett, D.G. (1980) 'Significance tests and goodness of fit in the analysis of covariance structures', *Psychological Bulletin*, Vol. 88, No. 3, pp.588–606, doi:10.1037/0033-2909.88.3.588.

Boute, R., Lambrecht, M., Lambrechts, O. and Sterckx, P. (2007) 'An analysis of inventory turnover in the belgian manufacturing industry, wholesale and retail and the financial impact on inventory reduction', *SSRN Electronic Journal*, doi:10.2139/ssrn.1089005.

Bryant, F.B. and Yarnold, P.R. (1995) 'Principal-components analysis and exploratory and confirmatory factor analysis', in Grimm, L.G. and Yarnold, P.R. (Eds.): *Reading and Understanding Multivariate Statistics*, pp.99–136, American Psychological Association, Washington, DC.

Cannon, A.R. (2008) 'Inventory improvement and financial performance', *International Journal of Production Economics*, Vol. 115, No. 2, pp.581–593, doi:10.1016/j.ijpe.2008.07.006.

Caudell, D. (2018) *Warehousing 101: An Introduction to Warehouse Automation* [online] https://www.rfgen.com/blog/warehousing-101-an-introduction-to-warehouse-automation/ (accessed 10 October 2020).

Creswell, J.W. (2013) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage Publications Ltd, USA.

David, B. (1996) *The Why of Inventory Management*, Pearson Education Ltd., England.

De Vries, J. (2011) 'The shaping of inventory systems in health services: a stakeholder analysis', *International Journal of Production Economics*, Vol. 133, No. 1, pp.60–69, doi:10.1016/j.ijpe.2009.10.029.

Field, A. (2013) *Discovering Statistics Using IBM SPSS Statistics*, Sage Publication Ltd, London.

Fornell, C. and Larcker, D.F. (1981) 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, Vol. 18, No. 1, pp.39–50, doi:10.1177/002224378101800104.

Fugate, B.S., Stank, T.P. and Mentzer, J.T. (2009) 'Linking improved knowledge management to operational and organizational performance', *Journal of Operations Management*, Vol. 27, No. 3, pp.247–264, doi:10.1016/j.jom.2008.09.003.

Games, P.A. (1984) 'Data transformations, power, and skew: a rebuttal to Levine and Dunlap', *Psychological Bulletin*, Vol. 95, No. 2, pp.345–347, doi.org/10.1037/0033-2909.95.2.345.

George, D. and Mallery, P. (2016) *IBM SPSS Statistics 23 Step by Step: A Simple Guide and Reference*, Routledge, New York, USA.

Gloet, M. and Samson, D. (2018) 'The role of knowledge management in innovative supply chain design', *Proceedings of the 51st Hawaii International Conference on System Sciences*, doi:10.24251/hicss.2018.524.

Gravetter, F. and Wallnau, L. (2014) *Essentials of Statistics for the Behavioral Sciences*, 8th ed., Wadsworth, Belmont, USA.

Guarte, J.M. and Barrios, E.B. (2006) 'Estimation under purposive sampling', *Communications in Statistics - Simulation and Computation*, Vol. 35, No. 2, pp.277–284, doi:10.1080/03610910600591610.

Hair, J. F, Babin, B., Money, A.H. and Samouel, P. (2003) *Essentials of Business Research Methods*, John Wiley & Sons, USA.

Hasanati, N., Permatasari, E., Nurhasanah, N. and Hidayat, S. (2019) 'Implementation of material requirement planning (MRP) on raw material order planning system for garment industry', *IOP Conference Series: Materials Science and Engineering*, Vol. 528, p.012064, doi:10.1088/1757-899x/528/1/012064.

He, Z., Aggarwal, V. and Nof, S.Y. (2018) 'Differentiated service policy in smart warehouse automation', *International Journal of Production Research*, Vol. 56, No. 22, pp.6956–6970, doi:10.1080/00207543.2017.1421789.

Hitt, M.A., Carnes, C.M. and Xu, K. (2015) 'A current view of resource based theory in operations management: a response to Bromiley and Rau', *Journal of Operations Management*, Vol. 41, No. 1, pp.107–109, doi:10.1016/j.jom.2015.11.004.

Hu, L. and Bentler, P.M. (1999) 'Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives', *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 6, No. 1, pp.1–55, doi:10.1080/10705519909540118.

Hult, G.T.M., Ketchen, D.J., Cavusgil, S.T. and Calantone, R.J. (2006) 'Knowledge as a strategic resource in supply chains', *Journal of Operations Management*, Vol. 24, No. 5, pp.458–475, doi:10.1016/j.jom.2005.11.009.

Inegbedion, H., Eze, S., Asaleye, A. and Lawal, A. (2019) 'Inventory management and organisational efficiency', *The Journal of Social Sciences Research*, No. 53, pp.756–763, doi:10.32861/jssr.53.756.763.

Jayakumaran, S., Shan, W.Z. and Daud, D. (2020) 'ABC analysis: a qualitative case study on inventory management in giant superstore Taman Connaught, an outlet of GCH Retail (Malaysia) SDN.BHD', *IOP Conference Series: Materials Science and Engineering*, Vol. 780, p.072016, doi:10.1088/1757-899x/780/7/072016.

Jonsson, P. and Mattsson, S-A. (2008) 'Inventory management practices and their implications on perceived planning performance', *International Journal of Production Research*, Vol. 46, No. 7, pp.1787–1812, doi:10.1080/00207540600988071.

Jöreskog, K.G. and Sörbom, D. (1981) *LISREL 5: Analysis of Linear Structural Relationships by Maximum Likelihood and Least Squares Methods*, University of Uppsala, Dep. of Statistics, Sweden.

Kamboj, S., Goyal, P. and Rahman, Z. (2015) 'A resource-based view on marketing capability, operations capability and financial performance: an empirical examination of mediating role', *Procedia – Social and Behavioral Sciences*, Vol. 189, pp.406–415, doi:10.1016/j.sbspro.2015.03.201.

Karmel, T.S. and Jain, M. (1987) 'Comparison of purposive and random sampling schemes for estimating capital expenditure', *Journal of the American Statistical Association*, Vol. 82, No. 397, pp.52–57, doi:10.1080/01621459.1987.10478390.

Khan, F. and Siddiqui, D.A. (2019) 'Impact of inventory management on firm's efficiency – a quantitative research study on departmental stores operating in Karachi', *Social Science and Humanities Journal*, Vol. 3, No. 4, pp.964–980 [online] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3400483.

Kolawole, A.D., Akomolafe, A.B. and Olusipe, B.J. (2019) 'Inventory management: an impetus for increased profitability in manufacturing firms', *International Journal of Accounting, Finance and Risk Management*, Vol. 4, No. 4, pp.110–115, doi: 10.11648/j.ijafrm.20190404.12.

Kolias, G.D., Dimelis, S.P. and Filios, V.P. (2011) 'An empirical analysis of inventory turnover behaviour in Greek retail sector: 2000–2005', *International Journal of Production Economics*, Vol. 133, No. 1, pp.143–153, doi:10.1016/j.ijpe.2010.04.026.

Kotzab, H. and Teller, C. (2005) 'Development and empirical test of a grocery retail instore logistics model', *British Food Journal*, Vol. 107, No. 8, pp.594–605, doi:10.1108/00070700510610995.

Koumanakos, D.P. (2008) 'The effect of inventory management on firm performance', *International Journal of Productivity and Performance Management*, doi:10.1108/17410400810881827.

Likert, R. (1932) 'A technique for the measurement of attitude', *Archives of Psychology* [online] https://legacy.voteview.com/pdf/Likert_1932.pdf (accessed 3 December 2019).

Liu, C.Y.D. and Ridgway, K. (1995) 'A computer-aided inventory management system – part 1: forecasting', *Integrated Manufacturing Systems*, doi:10.1108/09576069510076117.

Lysons, K. and Farrington, B. (2006) *Purchasing and Supply Chain Management*, Pearson Education, London.

Muchaendepi, W., Mbohwa, C., Hamandishe, T. and Kanyepe, J. (2019) 'Inventory management and performance of SMEs in the manufacturing sector of Harare', *Procedia Manufacturing*, Vol. 33, pp.454–461, doi:10.1016/j.promfg.2019.04.056.

Mulandi, C.M. and Ismail, N. (2019) 'Effect of inventory management practices on performance of commercial state corporations in Kenya', *International Academic Journal of Procurement and Supply Chain Management*, Vol. 3, No. 1, pp.180–197 [online] http://www.iajournals.org/articles/iajpscm_v3_i1_180_197.pdf.

Nunnally, J.C. (1978) *Psychometric Theory*, McGraw-Hill Book Company, NY.

Obermaier, R. and Donhauser, A. (2012) 'Zero inventory and firm performance: a management paradigm revisited', *International Journal of Production Research*, Vol. 50, No. 16, pp.4543–4555, doi:10.1080/00207543.2011.613869.

Obura, C.O. (2015) 'Influence of vendor managed inventory on organization performance in a manufacturing industry: a case of Unilever Kenya Limited', *International Academic Journal of Information Sciences and Project Management*, Vol. 1, No. 4, pp.19–29 [online] https://www.iajournals.org/articles/iajispm_v1_i4_19_29.pdf.

Ogbo, A.I. and Ukpere, W.I. (2014) 'The impact of effective inventory control management on organisational performance: a study of 7up Bottling Company Nile Mile Enugu, Nigeria', *Mediterranean Journal of Social Sciences*, Vol. 5, No. 10, p.109, doi:10.5901/mjss.2014.v5n10p109.

Otundo, J.B., Bichanga, W.O. and Bichanga, O. (2015) 'The effects of inventory management practices on operational performance of Kisii County Government, Kenya', *International Journal of Social Sciences and Information Technology*, Vol. 1, No. 4, pp.1–16 [online] http://www.ijssit.com.

Owoeye, E.S., Adejuyigbe, S.B., Bolaji, B.O. and Adekoya, A.F. (2014) 'Computerised inventory management for a manufacturing industry: a case study in Nigeria', *African Journal of Science, Technology, Innovation and Development*, Vol. 6, No. 4, pp.275–279, doi:10.1080/20421338.2014.947195.

Panigrahi, A. (2013) 'Relationship between inventory management and profitability: an empirical analysis of Indian cement companies', *Asia Pacific Journal of Marketing & Management Review*, Vol. 2, No. 7 [online] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2342455.

Panigrahi, R.R. and Jena, D. (2020) 'Inventory control for materials management functions – a conceptual study', *New Paradigm in Decision Science and Management*, pp.187–193, Springer, Singapore, doi:10.1007/978-981-13-9330-3_17.

Patel, H., Pitroda, J. and Bhavsar, J.J. (2015) 'Analysis of factor affecting material management and inventory management: survey of construction firms using RII method', *International Conference on Engineering: Issues, Opportunities and Challenges for Development*, pp.1–9, ISBN: 978-81-929339-1-7.

Pérez-Salazar, M. del R., Aguilar Lasserre, A.A., Cedillo-Campos, M.G. and González, J.C.H. (2017) 'The role of knowledge management in supply chain management: a literature review', *Journal of industrial Engineering and Management (JIEM)*, Vol. 10, No. 4, pp.711–788, doi:10.3926/jiem.2144.

Ranjan, J., Sudhansu, B., Singh, S., Chakraborty, S. and Ranjan, R. (2020) 'A vivid study of various spectrum sensing methods in CR network', *International Journal of Advanced Science and Technology*, Vol. 29, No. 4, pp.743–756 [online] https://www.ajol.info/index.php/ijest/article/view/68680.

Raviv, T. and Kolka, O. (2013) 'Optimal inventory management of a bike-sharing station', *IIE Transactions*, Vol. 45, No. 10, pp.1077–1093, doi:10.1080/0740817x.2013.770186.

Rushton, A., Croucher, P. and Baker, P. (2014) *The Handbook of Logistics and Distribution Management: Understanding the Supply Chain*, Kogan Page Publishers, London.

Samuel, I.S. and Ondiek, O. (2014) 'Inventory management automation and the performance of supermarkets in western Kenya', *International Journal of Research in Management & Business Studies*, Vol. 3, No. 5, pp.1–12 [online] http://ijrmbs.com/vol1issue4/kitheka_s.pdf.

Sharma, S., Abouee-Mehrizi, H. and Sartor, G. (2020) 'Inventory management under storage and order restrictions', *Production and Operations Management*, Vol. 29, No. 1, pp.101–117, doi:10.1111/poms.13097.

Shin, S. and Eksioglu, B. (2014) 'Effects of RFID technology on efficiency and profitability in retail supply chains', *Journal of Applied Business Research (JABR)*, Vol. 30, No. 3, pp.633–646, doi:10.19030/jabr.v30i3.8582.

Singh, V. (2020) *Efficiency of Manufacturing Industry with Odoo Application Development*, Oodles Technologies [online] https://erpsolutions.oodles.io/blog/improve-operational-efficiency-manufacturing-with-odoo-erp/ (accessed 14 June 2021).

SON, Y.K. (1991) 'A decision support system for factory automation: a case study', *The International Journal of Production Research*, Vol. 29, No. 7, pp.1461–1473, doi:10.1080/00207549108948023.

Sople, V. (2010) *Logistics Management*, 2nd ed., Dorling Kindersley, India, PVT, London.

Taticchi, P., Tonelli, F. and Cagnazzo, L. (2010) 'Performance measurement and management: a literature review and a research agenda', *Measuring Business Excellence*, Vol. 14, pp.4–18, DOI:10.1108/13683041011027418.

Tavana, M., Szabat, K. and Puranam, K. (Eds.) (2017) 'Organizational productivity and performance measurements using predictive modeling and analytics', *Advances in Business Information Systems and Analytics*, doi:10.4018/978-1-5225-0654-6.

The University of Texas (2012) *Structural Equation Modeling Using AMOS, An Introduction* [online] https://stat.utexas.edu/images/SSC/Site/AMOS_Tutorial.pdf (accessed 3 December 2019).

Tongco, M.D.C. (2007) 'Purposive sampling as a tool for informant selection', *Ethnobotany Research and applications*, Vol. 5, pp.147–158, doi:10.17348/era.5.0.147-158.

Tucker, L.R. and Lewis, C. (1973) 'A reliability coefficient for maximum likelihood factor analysis', *Psychometrika*, Vol. 38, No. 1, pp.1–10, doi:10.1007/bf02291170.

Waters, D. (2003) *Inventory Control and Management*, 2nd ed., pp.1–408, Wiley, ISBN-13: 978-0470858769.

Wolcott, H. (2000) *Logistics and Supplies Management*, Pearson Education Ltd., England.

Wu, Y., Liu, L. and Guo, Y. (2008) 'Knowledge inventory management using actuarial method', *Research and Practical Issues of Enterprise Information Systems II*, pp.1487–1495, Springer, Boston, MA, doi:10.1007/978-0-387-76312-5_81.

Yi, H.D., Park, S. and Kim, J. (2019) 'The effects of business strategy and inventory on the relationship between sales manipulation and future profitability', *Sustainability*, Vol. 11, No. 8, p.2377, doi:10.3390/su11082377.