A business process modelling approach in production logistics for small and medium-sized enterprises

T. Ramadas

A business process modelling approach in production logistics for small and medium-sized enterprises

T. Ramadas

Postgraduate School of Engineering Management,
University of Johannesburg,
Johannesburg, South Africa
Email: tramadas@gmail.com

Abstract: The primary objective of this research paper is to highlight the research work carried out in the area of production logistics for small and medium enterprises (SMEs) using a business process modelling approach. This paper provides a method of developing a logistic production model from the perspective of the business process modelling technique, which, to the best of our knowledge, has not been investigated before. Hence, this paper aims to design the logistic production model for SMEs, and in order to do that, business process modelling instruments were employed. The proposed conceptual model represents the workflow regarding logistic activities in small and medium-sized enterprises. The presented production logistic business process model is expected to help researchers, business modellers, analysts, and real professionals for further studies in logistic production management in the SME context.

Biographical notes: T. Ramadas is working as a Postdoctoral Fellow at the University of Johannesburg in the Faculty of Engineering Built Environment. His research interest focused on lean, green sustainability supply chain management, and total quality management. He has received several awards, including MHRD postgraduate, doctoral scholarships and postdoctoral fellowship.

1   Introduction

Business process modelling (BPM) is the central focus of business process management. It is an activity that describes the process of organisation of the current state or what it should become (Chinosi and Trombetta, 2011). However, in recent years, an expressive and understandable BPM language is suitable for all users. Currently, several modelling languages define the basics of creating business process models, and examples are Petri nets (PN) (Theiben et al., 2011), UML activity diagrams (OMG, 2007), business process

execution language for web services (BPEL) (OASIS, 2007), and business process modelling notation (BPMN) (OMG, 2011). This document aims to contribute to research on the suitability of BPMN in constructing a business process logistic model for small and medium-sized enterprises (SMEs). Although BPMN is highly applicable in the high-level description of business operations, there is an absolute gap in the processing of the semantics of object flows and its essential knowledge, which is intended to provide analysts and system developers.

The survival of SMEs is becoming more challenging in this dynamic era of globalisation (Shibin et al., 2016). Logistic chains become more global and complex, SMEs need to manage better, design and improve their logistic process (Asgari et al., 2015). The scope and role of logistics have changed tremendously. Logistics not only plays a supporting role in the functional area but is also limited to transportation and storage (Gunasekaran and Ngai, 2003). Logistics for managing the flow of goods, information, and other resources in the supply chain, including integrating information, transportation, inventory, warehousing, packaging, and security (Gunasekaran et al., 2007).

Along with the supply chain, the responsive logistics workflow management system serves as a significant value-adding channel of time and place utility (Lau et al., 2006). Cooper et al. (1994) highlighted that logistics is classified into procurement, production, and distribution. Procurement logistics is part of distribution logistics, so logistics management is classified into external and internal logistics.

Several studies have been conducted to analyse the logistic system in SMEs; however, a few reference models are available in applying logistic information in SMEs (Dean et al., 2007). Still, there is no standard representation of the logistic process model using the BPM technique (Khabbazi et al., 2011). So, the objective of this research paper is to develop the business process model in logistic activities for SMEs. This paper describes two aspects of contribution, first analysing the logistic business process for SMEs through the literature study, using BPMN, examining the complete syntax and semantics to cover the logistic modelling requirements for SMEs. Second, the proposed model is designed for the logistic activities in SMEs using the BPMN and activity diagram to represent the workflow of the logistic system that is significantly required from the perspectives of the business analyst and the model application systems architect. In addition, the meaningful explanatory description with an easy-to-understand strategy and technique for carrying out the logistic process in SMEs.

The rest of this article is organised as follows; the next part presents methodology is introduced. Further, it reviews the literature on the logistic process in SMEs and BPM. Then, it describes the development of the logistic business process model with the activity diagram. Finally, concluding comments and future research suggestions are provided.

2 Methodology

This article examined BPMN language with real-world practical examples for SMEs to recognise and highlight the problems and provide the requirements and solutions. To do this two-type method was followed:

a   literature research to investigate the theoretical part of language

b   followed by explanatory development of workflow logistic business process model using BPMN for SMEs.

3   Business process modelling

The term business process appeared in the 20th century and has matured through plans involving activities from flow diagrams to functional block diagrams. The American Center for Productivity and Quality (APQC) has established a proper practice format for business process definitions. According to the APQC definition, business processes capture the sequence of activity as performed by the business. BPM is a method of integrating an organisation into the needs and wants of its customers (Smith and Fingar, 2002). It is a comprehensive management approach that improves business efficiency and efficiency while striving for innovation, flexibility, and integration with technology. As companies seek to achieve their goals, BPM continuously defines, measures, and improves processes and optimise processes (Verma, 2009; Brocke and Rosemann, 2010). BPM is the central focus of business process management. It is an activity that describes the process of organisation of the current state or what it should become. However, in recent years, an expressive and understandable BPM language is suitable for all users. Currently, several modelling languages define the basics of creating business process models example, PN (Theiben et al., 2011), UML activity diagrams (OMG, 2007), BPEL (OASIS, 2007) and BPMN (OMG, 2011). There is a lot of research on the importance, quality, and applicability of modelling languages. Due to the complexity and error-prone tasks of modelling and designing business processes, many methods have emerged for modelling and analysing business processes (Van Dongen et al., 2005). Many of these methods provide a rich design environment that lacks accurate conceptual awareness, and the others have a clear conceptual basis but lack graphic expressiveness. Business engineering and information technology experts conclude that successful systems start with understanding an organisation's business processes (Barjis, 2008). In addition, business processes are a crucial element in enterprise integration (Aguilar-Savén and Olhager, 2002). Conceptual modelling of business processes has been implemented on a large scale to develop software that supports business processes, improves analytics, and reengineers daily (Aytuluna and Gunerib, 2008). There are many suggested techniques and patterns that are useful to follow. Mendling et al. (2010) advocate a set of seven guidelines for developing a quality business process model. Gunasekaran and Kubo (2002) provide guidelines for selecting modelling tools and techniques associated with the areas in which reengineering is to be performed. A lot of research has been carried out to assess the suitability and the capacities of modelling languages. Strembeck and Mendling (2011) report the lack of modelling language elements related to integrating processes and role-based access control. For this paper, we have not been able to provide a complete list of several papers on the suitability of using BPMN in recent years, but to our knowledge, there is no active example of investigation to highlight the semantic flow problems of objects in the use of BPMN.

4   SMEs and logistics

Logistics are significant for SMEs because they are the core of the company's link with the customer that generates revenue, which is the income generator for SMEs (Burt et al., 2010b). As business competition intensifies, logistic management significantly lowers operating costs and improves competitive benefits (Tantiwattanakul and Dumrongsiri, 2019). Logistics needs theoretical and conceptual foundations based on theories of different disciplines, such as marketing, purchasing, supply, business strategy, supply chain management (SCM), economics, organisational theory, and integrated management (Dekker et al., 2012). A clear understanding of companies' value culture and logistics in marketing, purchasing, supply, business strategy, supply chain management areas, and processes and management styles required to address these issues, can bring various benefits to the organisation (Escribá-Esteve et al., 2009). Logistics strategies also offer continuous improvement of customer relations to gain competitive priority. SMEs, especially with poor infrastructure, face more challenges to deliver the product on time; such problems can be overcome by making efficient logistic network improvements (Chung et al., 2018). Many authors believe that logistics is necessary for a competitive strategy for organisations struggling to respond to market changes, market share, and increased shareholder value (Bienstock et al., 2007; Koskinen and Hilmola, 2008). Logistics is seen as a strategy for monitoring competition, market development, and supply chain integration. It is also more flexible and responds to change more quickly to modification in the internal and external environment (Zhang et al., 2005). The drive to increase efficiency and reduce costs has forced many organisations to focus on limited key areas. Most large organisations outsource their logistic strategy to reduce costs and improve performance (McIvor, 2006). Logistics strategies also offer continuous improvement of customer relations to gain competitive priority. Many authors believe that logistics is necessary for a competitive strategy for organisations struggling to respond to market changes, market share, and increased shareholder value (Bienstock et al., 2007; Koskinen and Hilmola, 2008).

SMEs starting with individual entrepreneurs are motivated to discover and take advantage of new opportunities in society (Burke, 2006). As a result, SMEs are similar to new startups, especially in risk, flexibility, and practical management of innovation/creativity (Ellegaard, 2006). Compared with large companies, SMEs have also created essential employment opportunities, reduced the gap between urban and rural development, reduced poverty, and increased employees in each investment sector (Chen, 1999). Besides, SMEs are the source of new ideas, processes, and services that large organisations cannot provide (Nielsen and Thomsen, 2009). SMEs make fast decisions, timely availability of products and services, raw materials, innovative products that meet the needs of the individual in the economy (Karjalainen and Kemppainen, 2008). In support, Abraham (2017) emphasised that SMEs have the advantages of flexibility, response time, and innovation ability and are at the economy's core. Therefore, SMEs are often referred to as "the cornerstones of economic development and growth".

Logistics strategy is one of the main reasons for the company's existence that connects companies and customers and helping organisations survive for business success (Chopra and Meindl, 2010). The logistics strategy forces organisations to further extend the reach of their business activities, which can be more difficult as product life cycles become shorter, product variety increases, and technological advances progress at an exponential rate. Logistics can also be conceptualised within the principles of value in

products and services created for the company and delivered to end customers (McKinnon, 2009). Logistics creates added value and brings capital to the organisation to extend the product life cycle for continuous improvement and product development (Kruse and Dinjus, 2007). However, this goal can only be achieved by carefully launching, developing, and implementing a logistics strategy (Daskin, 2010). It seems that the organisation's efficiency and performance can be improved if the logistics strategy is addressed as a critical business process (Benjaafar et al., 2010). Marketers inform customers about the product and its benefits and explain how they use it and obtain it. Based on this impulse, the customer finally places an order. When a customer places an order, something happens along the chain that the market demands to keep its promise, a logistic function (Burt et al., 2010b). It shows that logistics bridges the gap between manufacturers or suppliers, traders, and consumers. How SMEs implement their logistics strategy determines their commitment to customers and their profitability relationships (Hong and Jeong, 2006).

A study by Anja et al. (2009), focusing on SMEs in Germany, shows that logistics strategy is essential for SMEs, which results in increased profitability due to added value and competitive advantage that leads to profit maximisation. Also, another study by Mason et al. (2003) found that SMEs in the USA seek to maximise the value of each stage of the logistics chain and strive to optimise the functioning of the entire supply chain in areas such as product delivery time, cost of inventory maintenance and the total cost of marketing. To succeed, SMEs need to understand the importance of implementing a logistic strategy and focus on customer needs to maintain market share and ensure growth (Hong and Jeong, 2006). In addition, SMEs lack technical talent, research, and development, finance, and education (Cocca and Alberti, 2010). As the main driver of economic growth, facing the challenges of national, international, and globalisation, SMEs need to develop strategies to increase competitiveness and provide superior product design and performance (Deros et al., 2006). Another challenge for SME logistics functions involves the complexity associated with inventory management, which is related to the confusion that there is too little inventory to meet high demand or secure a company's cash flow.

In some cases, SMEs struggle to provide the right product at the right operational level (Hamisi, 2011). Abonyi et al. (2005) pointed out that due to size and apartheid restrictions, most small businesses are prohibited from achieving economies of scale when purchasing key inputs (such as equipment, raw materials, financial, and consulting services). As a result, SMEs are often unable to identify potential markets; Moreover, they cannot take advantage of existing market opportunities that require reliable quality and acceptance standards and ensure that their products are regularly delivered to customers (Udin et al., 2006).

5   Development of BPM logistic system for SMEs – explanatory modelling technique

The term modelling is a type of simulation where a sequence of related phases constitutes a process. These processes are analysed, studied, and executed repeatedly to improve the performance of the business process. Therefore, the purpose of BPM is to optimise the efficiency of performing business processes and activities related to the production of

products and services. Figure 1 represents the necessary logistic activities in SMEs and the workflow of basic HR activities described in the below section.

Figure 1 Logistic business process model for SMEs
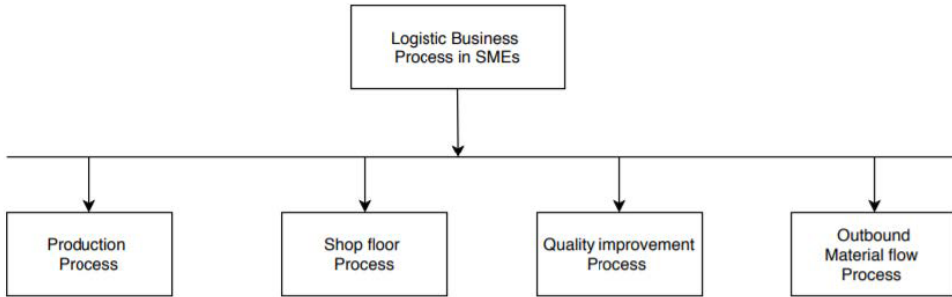
5.1 Development of business process model for the production process

The logistic BPM represents how the work order is executed by responding to the customer order received at its highest domain level. The next step is the sequential flow of the process to fill the customer order from a start event up to the end event represented in Figure 2.

**Figure 2** Production process model
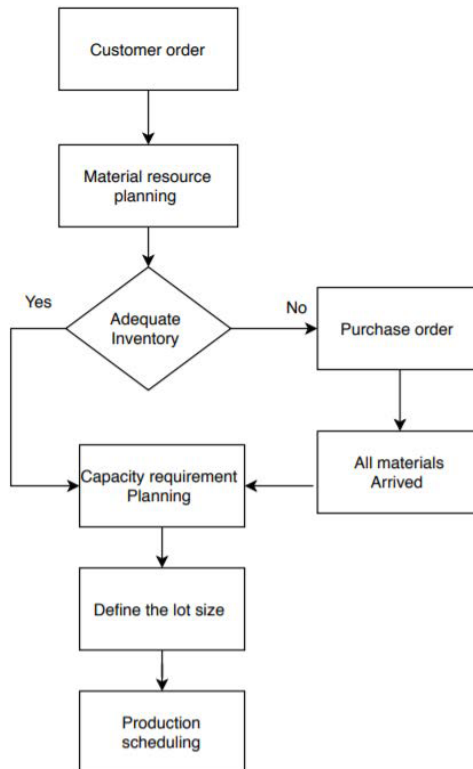
The production process starts with customer orders from the sales department. Then, manufacturing resource planning enables manufacturers to access real-time data to coordinate resources such as labour availability, parts, and materials delivery to create detailed production plans. Manufacturing resource planning ensures and achieves three goals: guarantee the material and product availability, materials and product management, and develop manufacturing, scheduling, and purchasing plan. Then check the inventory. If there are enough materials in the inventory, continue with capacity requirement planning; otherwise, wait for the purchased items to arrive. Capacity requirement planning is how SMEs understand the quantity required for production and determine whether it can meet these production goals. Businesses that experience seasonal waves depend on the industry and type of SME businesses, and capacity requirements planning can happen monthly, quarterly, or annually. The final stage is lot-sizing. It refers to the number of items ordered for delivery on a specific date or manufactured in the single production stream.

5.2   Development of business process model for the shop floor process

The objective of the shop floor process is to assist the sustainable development of procedures when creating a product. The shop flow process involves the manufacturing, assembly, processing, and controlling related tasks of the product. The shop floor is an essential part of the organisation where the actual action occurs. A shop floor is responsible for delivering consistent and high-quality products in terms of features. The shop floor process consists of the following steps and stages described in Figure 3.

**Figure 3**   Business process model for the shop floor
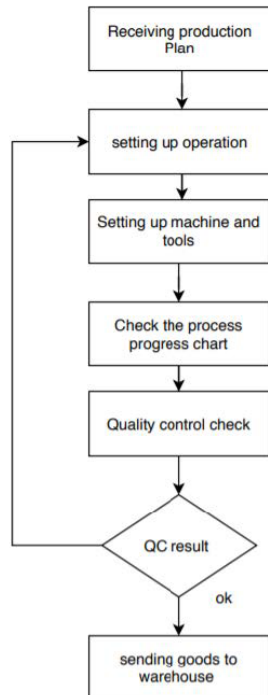
After receiving the production plan on the shop floor, the set of required resource tasks will configure the allocation of resources, the configuration of the machine tools, and supplement instructions. Then check the progress of the production planning process. When the production process is completed, the product is checked for quality control; if the product is good, it is shipped to the warehouse, or otherwise, it will notify for rework and back to the reproduction.

5.3 Development of business process model for the quality improvement operation

Quality control (QC) is the process by which a company maintains or improves product quality. Quality management requires creating an environment where management and employees strive for perfection. Quality improvement (QI) is defined as the process and sub-processes that help the company deliver better results to its customers or reduce deviations from the standards. One of the critical issues here is the ability to detect variance and act on variation. The quality improvement process consists of the following steps and stages described in Figure 4.

**Figure 4** Business process model for quality improvement operation
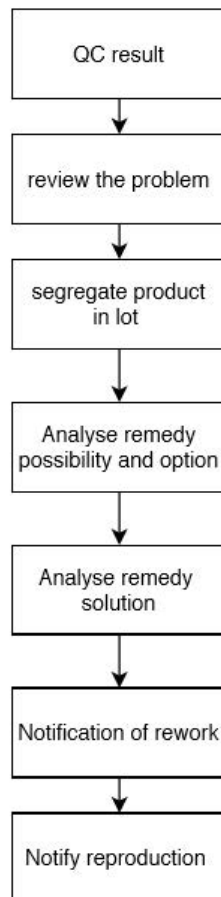
Quality operational activity is carried out by collecting samples output from the operating process. Examine quality control results and root causes of problems. Next, separate the defective lot product from the batch and finalise the remedial action plan. Notify the rework or reproduction and inform the production department.

5.4   Development of business process model for outbound material flow

Inbound and outbound logistics play a vital role in the flow of goods and services and the timely delivery of goods to the plant and the customer. External mobility of end or finished products from the company to end-user is known as outgoing logistics. Focus on transporting finished products or products from the company to the end-user. That includes shipping costs, customs clearance, and internal transportation, incoming and going logistics information. The business process flow diagram consists of the following steps and stages described in Figure 5.

Figure 5   Business process model for outbound material flow operation
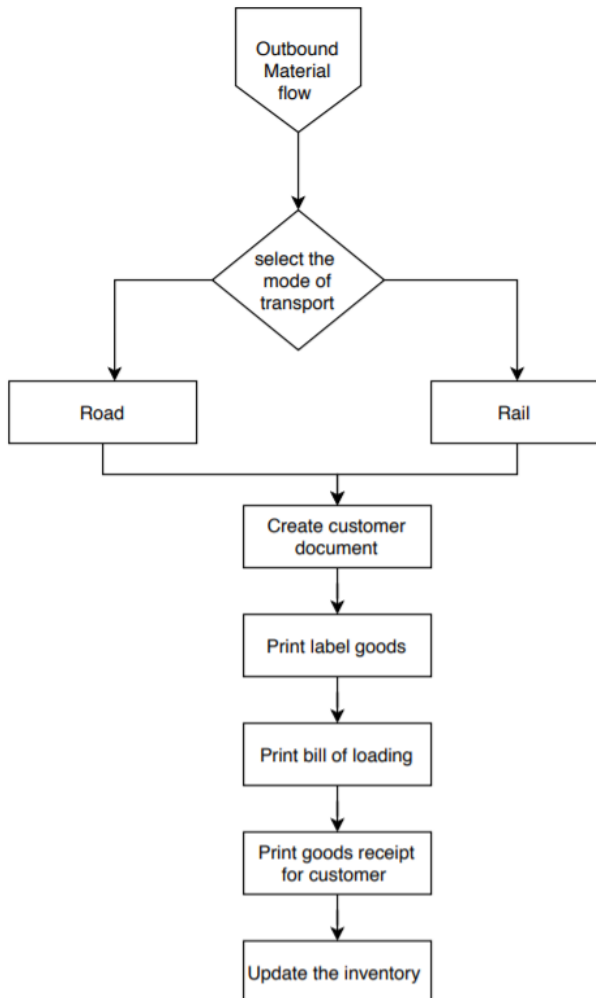
6   Result and discussion

This paper focused on the relevance of BPMN as a main standard method for capturing critical logistic processes in SMEs. Production logistics were modelled as a real industrial system using BPMN. That can be used to describe the entire scenario through a series of activities (i.e., process and subprocess in BPM). BPM is a standard representation of the system that provides a high-level analytical perspective of the business process required for system developers and analysts. The use of BPM, the workflow of operation, cannot fully be elaborated because it is a standard method to model the events that occur to initiate a process, the process carried out, and the final results of the process flow. BPM of the logistic system that represents activities such as receiving of goods and deploying resources are modelled as tasks or events. Without the connectivity of events, BPM cannot model the flow of a specific physical object. The functional diagram used to explain the logistic process in SMEs describes the entire scenario through a series of activities. The developed logistic business process model for SMEs helps understand how it works even to a non-technical user and supports system architecture software developers better. Besides, the proposed business process model provides a general and empirical guide to a more personalised data resource and a step in the data modelling requirements for the logistics system. Practical explanations and easy-to-understand strategies and techniques for modelling business processes are considered another critical feature of this paper.

7   Conclusions and future work

This paper provides a method of enabling logistic strategies for SMEs from the perspective of BPM that has not been investigated before to the best of our knowledge. Our proposed BPM model refers to:

1   design the logistic business process model for SMEs

2   to identify the logistic process and its subprocess in SMEs.

Future work includes expanding the proposed model by identifying more logistic activities in SMEs and their implementation.

References

Abonyi, J., Feil, B., Nemeth, S. and Arva, P. (2005) 'Modified Gath-Geva clustering for fuzzy segmentation of multivariate time-series', *Fuzzy Sets and Systems*, Vol. 149, No. 1, pp.39–56.

Abraham, T.S. (2017) 'Commercialising technical innovation: role of business incubators in Kerala', *Journal of Entrepreneurship & Organization Management*, Vol. 6, No. 2, pp.3–10.

Aguilar-Savén, R.S. and Olhager, J, (2002) 'Integration of product, process and functional orientations principles and a case study', *APMS Kluwer*, pp.375–389.

Anja, S., Thomas, B. and Sascha, K. (2009) 'International entrepreneurship: towards a theory of SME internationalization', *Journal of International Business and Economics*, Vol. 9, No. 1, pp.1–12.

Asgari, N., Nikbakhsh, E., Hill, A. and Farahani, R.Z. (2015) 'Supply chain management 1982–2015: a review', *IMA Journal of Management Mathematics*, Vol. 27, No. 3, pp.353–379.

Aytuluna, S.K. and Gunerib, A.F. (2008) 'Business process modeling with stochastic networks', *International Journal of Production Research*, Vol. 46, No. 10, pp.2743–2764.

Barjis, J. (2008) *The Importance of Business Process*.

Benjaafar, S., Li, Y. and Daskin, M. (2010) *Carbon Footprint and the Management of Supply Chains: Insights from Simple Models* [online] http://www.ie.umn.edu/faculty/faculty/pdf/beyada-3-31-10.pdf (accessed 24 January 2020).

Bienstock, C.C., Royne, M.B., Sherrell, D. and Stafford, T.F. (2007) 'An expanded model of logistics service quality: Incorporating logistics information technology', *International Journal of Production Economics*, Vol. 133, No. 1, pp.205–222.

Brocke, J. and Rosemann, M. (2010) *Handbook on Business Process Management 1: Introduction, Methods, and Information Systems*, Springer.

Burke, R. (2006) *Small Business SMEs: Guide to Running Business*, Thames and Hudson, Burke Publishing, UK.

Burt, D., Petcavage, S. and Pinkerton, R. (2010a) *Supply Management*, 8th ed., McGraw-Hill, Boston.

Burt, D., Petcavage, S. and Pinkerton, R. (2010b) *What Impact Does Training Have on Employee Commitment and Employee Turnover* [online] http://www.uri.edu/research/papers/Burn commitment pdf (accessed 2020 January 10).

Chen, W.H. (1999) 'The manufacturing strategy and competitive priority of SMEs in Taiwan: a case survey', *Asia Pacific Journal of Management*, Vol. 16, No. 3, pp.331–349.

Chinosi, M. and Trombetta, A. (2011) 'BPMN: an introduction to the standard', *Computer Standards & Interfaces*, Vol. 34, No. 1, pp.124–134.

Chopra, S. and Meindl, P. (2010) *Supply Chain Management, Strategy, Planning and Operation*, Pearson, Upper Saddle River, New Jersey.

Chung, K.H., Ko, S.Y. and Ko, C.S. (2018) 'A cooperative game-theoretic network design for collaborative operation of service centers and consolidation terminals in delivery services', *International Journal of Industrial Engineering*, Vol. 25, No. 1.

Cocca, P. and Alberti, M. (2010) 'A framework to assess performance measurement systems in SMEs', *International Journal of Productivity and Performance Management*, Vol. 59, No. 2, p.186200.

Cooper, J., Browne, M. and Peters, M. (1994) *European Logistics: Markets, Management and Strategy*.

Dean, P.R., Tu, Y.L. and Xue, D. (2007) 'An information system for one-of-a-kind production', *International Journal of Production Research*, Vol. 47, No. 4, pp.1071–1087.

Dekker, R., Bloemhof, J. and Mallidis, I. (2012) 'Operations research for green logistics: an overview of aspects, issues, contributions and challenges', *European Journal of Operational Research*, Vol. 219, No. 3, pp.671–679.

Deros, B.M., Yusof, S.M. and Salleh, A.M. (2006) 'A benchmarking implementation framework for automotive manufacturing SMEs', *International Journal of Benchmarking*, Vol. 13, No. 4, pp.396–430.

Ellegaard, C. (2006) 'Small company purchasing: a research agenda', *Journal of Purchasing & Supply Management*, Vol. 12, No. 5, pp.272–283.

Escribá-Esteve, A., Sánchez-Peinado, L. and Sánchez-Peinado, E. (2009) 'The influence of top management teams in the strategic orientation and performance of small and medium-sized enterprises', *British Journal of Management*, Vol. 20, No. 4, pp.581–597.

Gunasekaran, A. and Kubo, B. (2002) 'Modelling and analysis of business process reengineering', *International Journal of Production Research*, Vol. 40, No. 11, pp.2521–254.

Gunasekaran, A. and Ngai, E.W.T. (2003) 'The successful management of a small logistics company', *International Journal of Physical Distribution &Logistics Management*, Vol. 33, No. 9, pp.825–842.

Gunasekaran, A., Ngai, E.W.T. and Cheng, T.C.E. (2007) 'Developing an e-logistics system: a case study', *International Journal of Logistics Research and Applications*, Vol. 10, No. 4, pp.333–349.

Hamisi, S. (2011) 'Challenges and opportunities of Tanzanian SMEs in adapting supply chain management', *African Journal of Business Management*, Vol. 5, No. 4, pp.1266–1276.

Hong, P. and Jeong, J. (2006) 'Supply chain management practices of SMEs: from a business growth perspective', *Journal Enterprise Information Management*, Vol. 19, No. 3, pp.292–302.

Karjalainen, K. and Kemppainen, K. (2008) 'The involvement of small-and medium-size enterprises in public procurement: Impact of resource perceptions, electronic systems and enterprise size', *Journal of Purchasing & Supply Management*, Vol. 14, No. 4, pp.230–240.

Khabbazi, M.R., Ismail, M.Y., Ismail, N., Mousavi, S.A. and Mirsanei, H.S. (2011) 'Lot-base traceability requirements and functionality evaluation for small to medium-sized enterprises', *International Journal of Production Research*, Vol. 49, No. 3, pp.731–74.

Koskinen, P. and Hilmola, O.P. (2008) 'Supply chain challenges of North-European paper industry', *Journal of Industry Management & Data Systems*, Vol. 108, No. 2, pp.208–227.

Kruse, A. and Dinjus, E. (2007) 'Hot compressed water as reaction medium and reactant: properties and synthesis reactions', *The Journal of Supercritical Fluids*, Vol. 39, No. 3, pp.362–380.

Lau, H.C.W., Lee, C.K.M., Ho, G.T.S., Choy, K.L. and Bartholomew, P.K.L. (2006) 'Design of an adaptable logistics workflow management system for e business', *International Journal of Agile Systems and Management*, Vol. 1, No. 4, pp.329–345.

Mason, J.M., Konev, A.Y. and Biessmann, H. (2003) 'Telomeric position effect in Drosophila melanogaster reflects a telomere length control mechanism', *Genetica*, Vol. 117, No. 2, pp.319–325.

McIvor, R. (2006) 'How the transaction cost and resource-based theories of the firm inform outsourcing evaluation', *Journal of Operations Management*, Vol. 27, No. 1, pp.45–63.

McKinnon, A. (2009) The present and future land requirements of logistical activities', *Land Use Policy*, Vol. 26, pp.293–301.

Mendling, J.H., Reijers, A. and W.M.P. Van der Aalst, Mendling, (2010) 'Seven process modeling guidelines (7PMG)', *Information and Software Technology*, Vol. 52, pp.127–136.

Nielsen, A.E. and Thomsen, C. (2009) 'CSR communication in small and medium-sized enterprises: A study of the attitudes and beliefs of middle managers', *International Journal of Corporate Communications*, Vol. 14, No. 2, pp.176–189.

OASIS (2007) *Web Services Business Process Execution Language Version 2.0*, Committee Specification.

OMG (2007) *Unified Modeling Language: Superstructure*, Technical Report Version 2.1.1.

OMG (2011) *Business Process Model and Notation (BPMN 2.0), Formal/2011-01-03*, July [online] http://www.omg.org/spec/BPMN/2.0.

Shibin, K.T., Gunasekaran, A. and Papadopoulos, T (2016) 'Enablers and barriers of flexible green supply chain management: a total interpretive structural modeling approach', *Glob. J. Flex. Syst. Manag.*, Vol. 17, No. 2, pp.171–188.

Smith, H. and Fingar, P. (2002) *Business Process Management the Third Wave*, Meghan-Kiffer Press.

Strembeck, M. and Mendling, J. (2011) 'Modeling process-related RBAC models with extended UML activity models', *Information and Software Technology*, Vol. 53, pp.456–48.

Tantiwattanakul, P. and Dumrongsiri, A. (2019) 'Multi-period supply chain coordination using trade promotion: complementary slackness approach', *International Journal of Industrial Engineering*, Vol. 26, No. 4.

Theiben, M., Hai, R. and Marquardt, W. (2011) 'A framework for work process modeling in the chemical industries', *Computers and Chemical Engineering*, Vol. 35, No. 4, pp.679–691.

Udin, Z.M., Khan, M.K. and Zairi, M. (2006) 'A collaborative supply chain management framework. Part 1 planning stage', *Business Practice Management Journal*, Vol. 1, No. 5, pp.671–687.

Van Dongen, B.F. van der Aalst, W.M.P., Mendling, J.H., Reijers, A. and Verbeek, H.M.W. (2005) 'Verification of EPCs: using 2010. Seven process modeling guidelines reduction rules and Petri nets', *17th Conference on (7PMG). Information and Software Technology, Advanced Information Systems Engineering*.

Verma, N. (2009) *Business Process Management: Profiting from Process*, Global India Publcations.

Zhang, Q., Vonderembse, M.A. and Lim, J.S.U. (2005) 'Logistics flexibility and its impact on customer satisfaction', *International Journal of Logistics Management*, Vol. 16, No. 1, pp.71–95.