

Supply Chain Management of Facility Operations and Maintenance Function in Apparel Sector

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Abstract

A facility cannot be smoothly operated if not properly maintained. Hence, facility operations and maintenance (O&M) function has obtained a noteworthy recognition due to its significant contribution made for the continuous operation of a facility, core-business performance and occupant's satisfaction. However, the diverse nature of facility O&M functions necessitates effective supply chains. In particular, the crucial elements engaged in O&M functions such as the parties involved, information flows, finance flows and service/product flows have been neglected in previous studies. Hence, this study aims to develop a model for supply chain management of facility O&M function in apparel sector. Given the importance of apparel manufacturing to Sri Lankan national economy, the study was focused on apparel factories. An in-depth literature review followed by case study design under qualitative approach was deployed for empirical investigation. The collected data was analysed using manual content analysis and using QSR N-Vivo software. According to the case study findings, supply chain management in O&M functions is carried out in ad-hoc manner in case study organisations. The study developed a SCM process for facility O&M functions incorporating three O&M sub processes; i.e. (a) customer relationship management, (b) internal supply chain management, and (c) supplier relationship management. The research findings can be used as a guide by the facility O&M teams for optimising the performance of O&M supply chain functions.

Keywords

Facility operations and maintenance, Supply Chain, Supply Chain Management Process

1. Introduction

Apparel industry had played a principal role in taking off the Sri Lanka's economic status since it was unleashed and liberalized in 1977 (Board of Investment [BOI], 2018). It has become the largest gross export earner since 1986 accounting for more than 56% of exports and the country's largest net foreign income earner since 1992 (Dheerasinghe, 2009). According to Philbrihty (2016), in order to maintain competitive advantage, speed is an important parameter in Sri Lankan textile manufacturing. Superseding the history of maintaining 6 months of lead time every year, the industry has reached a 6 weeks of lead time in order to meet the fast and reactive fashion models (Philbrihty, 2016). Improved maintenance value stream assist in reducing lead time through reduction of downtime (Mostafa et al., 2015). Maintenance in manufacturing at a greater degree determines the production quality and quantity and has a direct impact on production cost and satisfaction (Al-Turki et al., 2014). According to the authors, the role of maintenance in maintaining assets over its life time is becoming more perceptible given the increase acquisition of assets and its maintenance costs. The study carried out by Monageng et al. (2018) targeting textile manufacturing factory stressed the importance of maintenance in manufacturing textile to fulfil the demand of local and international customers.

Maintenance comprises all work referring to the economic preservation of facilities, systems, and tools at an acceptable level to perform their desired functions (Lewis and Payant, 2007). According to Lai and Yik (2007), the performance of buildings are based on the good practices on operation and maintenance (O&M) of facilities, which comprise of service installations such as air-conditioning, electrical, fire protection, and plumbing and drainage installations. O&M of buildings has become critical to the extent that no building could sustain whether old or new in

long term without proper O&M (Lai, 2010). This view was supported by Tan et al. (2014) stating that effective maintenance contribute towards spanning building life cycle in addition to ensuring a safe and comfortable environment for occupants. However, the workload and unpredicted reactive maintenance causes disruption to business activities (Ali et al., 2006). Uche and Ogbonnaya (2013) identified major maintenance challenges faced by three manufacturing facilities in Nigeria as unavailability of spare parts and length of time taken for placing of orders and ordering critical spare parts from supply chain. As a consequence of the pressure generated from the market in search of innovative solutions, constant cost reduction added to the requirement of gaining competitive advantage to succeed in business, ensuring integrated supply chain in maintenance is paramount (Haddud, 2017). Hence, this study aims to develop a model for supply chain management of facility O&M function in apparel sector. The paper structure begins with an introduction to the study and followed by a literature review on operations and maintenance management, supply chain of O&M, supply chain management and a conceptual model was presented in Section 2. Section 3 presents the research methodology followed by research findings and discussion in Section 4. The final section summarises conclusions derived from the research findings and present recommendations.

2. Literature Review

2.1 Evolution of Maintenance Approaches

History of maintenance bears witness for the initial maintenance approach implemented before 1950s as corrective maintenance (McKone and Weiss, 1998). The initiation was considered as the first generation of maintenance, which ranged from 1940s to 1950s (Uche and Ogbonnaya, 2013). According to Jafari et al., (2008), an item under corrective maintenance would be repaired once it is prone to a breakdown disregarding the necessity of monitoring its ongoing condition to detect failures. In such a context, failures may occur in unforeseen ways and the unpredictability of impacts could escalate the cost compared to expected (Lind and Muyingo, 2012). In order to overcome the failures of unplanned downtime, preventive maintenance was advocated as the best practice in 1950s (Dekker, 1996). This period ranging from 1950s to 1977 was considered as second generation of maintenance (Uche and Ogbonnaya, 2013). Tsang (2002) describe preventive maintenance as actions carried out in a predetermined time period despite the actual condition of building, plant and equipment. The overriding cost created by unplanned maintenance proves the requirement of preventive maintenance, which will further ensure the safety of equipment and employee (Oke et al, 2006). Authors further stressed that implementing preventive maintenance to be more economical in long term as it is more cost effective than replacing the whole equipment.

In 1970's, Condition Based Monitoring (CBM) came forward, applying on techniques that predict failures using details on the actual condition of equipment and CBM confirmed to be much beneficial than the large time-based preventive maintenance (Dekker, 1996). Similarly, El-Ferik and Ben-Daya (2010) stated that CBM can be an optional and cost-saving approach compared to time-based maintenance. Some of the techniques that used in CBM highlighted by Tsang (2002) as performance-parameter analysis, vibration monitoring, thermography, oil analysis and ferrography. However, the period from 1978 to 2000 was considered as the third generation of maintenance by Uche and Ogbonnaya (2013). During the period several maintenance approaches came in to light. According to Pintelon and Parodi-Herz (2008) reliability centred maintenance is a third generation maintenance approach. According to Gupta and Mishra (2016), many authors had made initiations to develop reliability centred maintenance since 1960. The concept focused on forming the maintenance strategy by selecting the ideal mix of corrective maintenance, scheduled-based maintenance and condition based maintenance to fully support the process of ensuring reliability (Prajapati et al., 2012). Total Productive Maintenance (TPM) was initially implemented in a company called Nippondenso in USA (Venkatesh, 2007). Though the plant was adopting preventive maintenance practices with the automation of the systems maintenance had become a huge issues and more maintenance personnel were required. In order to overcome the issue, operators were trained to undertake routine maintenance, which gave birth to the concept called autonomous maintenance under TPM (Venkatesh, 2007). As defined by Sharma and Shudhanshu (2012) achievement of zero defects, zero failures, and zero accidents in order to clear all losses was considered as the aim of the TPM. However, late 1970s and early 1980 had set a different impression in maintenance history with emergence of lifecycle engineering (Pintelon and Parodi-Herz, 2008). Yet, according to Lee and Akin (2011), majority (86%) of maintenance activities are reactive and preventive despite the evolution of several maintenance concepts.

2.2 Operation and Maintenance Function of a Facility and Its Supply Chain

The terms operation and maintenance is usually discussed as one term due to the fact that a facility cannot be operated if not properly maintained (Don Sapp, 2017). According to Liyanage (2007), O&M is a technical process, which in line to production and manufacturing environment provide incessant assurance on the condition of the facility and its physical assets during the whole life time. Lee and Akin (2009) in his study identified several organisations, which achieved high savings through the implementation of good practices in O&M. As examples, Pacific Northwest National Laboratory (PNNL) in United States has increased its output efficiency by 13% and Portland Energy Conservation, Inc. (PECI) had stated that decent operations of facility and equipment itself could save 5-20% of energy without significant investments. O&M is the longest period of the life cycle of a building, there by a significant amount of expense is occurred during the period and account for more than 85% of total cost spent on facility (Lee and Akin, 2011). According to Staff (2013), organizational maintenance, repair and operations inventory accounts a significance portion (40%) of annual procurement budget. Yik and Lai (2005) stated that the O&M cost of a building (in house costs, outsourced contract sum, transaction cost) is effected by several factors, which are quality demand of users, building service provision (rang, scale and complexity) and O&M work execution (in-house, outsourced contractors). Hence, it is required to manage the user requirements and ensure suppliers' selection to be cost effective in order to optimize O&M cost. In addition to customers who are demanders and suppliers or contractors, Ali et al. (2006) had identified facilities management team and clients as important parties engaged in maintenance. According to the authors, client is the organisation who owns the property and responsible to pay for repairs, contractors are responsible for carrying out the work and FM team either in-house or outsourced manage the contract between client and contractors. According to Tian (2009), focusing on internal supply chain integration, which links internal departments is paramount to ensure effective operations in the business. Moreover, in order to optimize maintenance supply chain, it is necessary to focus on maintenance supplies. O&M involves several maintenances items such as supplies, spare parts and consumables, which include oils lubricants and cleaning products, gloves and safety equipment (Murray, 2017). Beside a product/ service flow as described above a finance flow occurs along the maintenance value chain due to the necessity of recompensing for the purchased service and products.

Tan et.al (2018) stressed that various information flows are involved among the parties such as contactors, consultant, suppliers and sub-contractors in managing facilities. According to Dillibabu (2017), information flow plays an unique role in O&M and O&M demand information from various parties such as IT team, technicians, finance team, certification bodies, event management teams, contractors and more. Moreover, maintenance planning evidence, maintenance budgetary control evidence, maintenance performance and plant reliability measurement and control, inventory control and evidence, maintenance work realization and documentation and info distribution are information identified by Spuzic (2005, p.258) relevant for maintenance. In addition, Physical information (equipment and system operating parameters, warranties, inspection and maintenance schedules, maintenance and cleaning products and tools and spare parts), Legal information (cases, zoning and building codes and safety and environmental regulations) and Financial information (lease or operating revenue, depreciation schedules and operations and maintenance costs) were identified under information categories, which are essential for Facilities Managers, owners, tenants, service providers and suppliers of a facility during O&M phase (Fallon and Palmer, 2006, p.14). Hence, most of the activities undertook under O&M in a facility are linked to a supply chain comprised of parties and information, service/product and finance flows occurred between the parties. However, a proper management process is required to govern the elements in the O&M supply chain in order to sustain the benefits gained through supply chain in long term.

2.3 Supply Chain Management

Supply chain involves movement of goods and information among different stakeholders who include customers, retailers, distributors, manufacturer and raw material suppliers (Bawa, 2014). According to Afolayan et al. (2016), the chain of networks, which links several players as to suppliers, retailers, distributors and manufacturing sites is considered as a supply chain. Figure 1 demonstrates a typical supply chain.

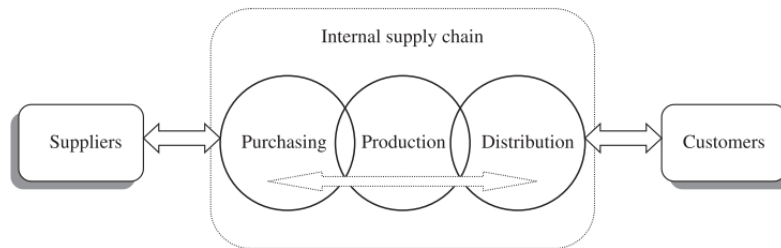


Figure 1: A Typical Supply Chain
Source: (Chen and Paulrajy, 2004)

Product/service, information flows and finance flows are considered as important elements of a supply chain (Felea and Albastroiu, 2013). The concept of Supply Chain Management (SCM) has been born due to the requirements of managing the flows of information, product and service along the network of customers, suppliers and supply chain partners (Russell and Taylor-Iii, 2008). SCM can be defined as “The integration of trading partners’ key business processes from initial raw material extraction to the final or end customer, including all intermediate processing, transportation and storage activities and final sale to the end product customer” (Wisner et al., 2014, p.24). According to Dubey and Ali (2013), SCM is “The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole” (P. 192). Eric (2011), stresses that definitions on SCM varies in accordance to focus, perspective and scope. The analysis of several SCM definitions by Felea and Albastroiu (2013) had brought the authors into conclusion that SCM represents an holistic approach for the operation of organisation for practitioners and for theorists it is a melting pot of several disciplines such as logistics, transportation, operations management, distribution, marketing, purchasing and information technology. Organizations such as Walmart and Amazon are continuing to grow by the use of effective SCM by reducing product cost and in turn providing customers with product and services of lower cost (Bonney, 2012). SCM is said to support organisational competitive strategy (Ellram and Cooper, 2014). According to the authors, the common principles that encourages the adoption of SCM are information transparency, dissection of supplier, customer service, lean principles, quality, improved communication, segmentation and stock management, which may apply in different industries based in their competitive strategies.

SCM involves integrating organizational units along the supply chain (Stadtler, 2005). In order to build this link between supply chain units, it is vital to implement a standard set of supply chain process (Croxtton et al., 2001). Lambert and Cooper (2000) identified supply chain business process as to processes that should be linked with key supply chain members. The framework presented by Cooper et al. (1997) discuss three closely related element of supply chain as to supply chain business process, SCM component and supply chain network structure. In addition, Chopra and Meindl (2014) discussed on supply chain macro-process in a firm and elaborated on three process in order to manage the flow of information, product and funds to meet customer requirements. The process has been elaborated in Table 1.

Table 1: SCM Process

Supplier	Firm	Customer
Supplier Relationship Management (SRM) Interface between supplier and firm. Arrange and mange supply sources	Internal Supply Chain Management (ISC) All activities internal to firm. It aims at fulfilling demand generated by CRM in a timely and cost effective manner	Customer Relationship Management (CRM) Interface between customer and firm. Aim at making customer order and tracking them
Design collaboration Source Negotiate Buy Supply collaboration	Strategic planning Demand planning Supply planning Fulfilment Field service	Market Sell Call centre Order management

Source: (Chopra and Meindl, 2014)

SRM is the interface between supplier and firm while arranging and managing supply sources, and ISCM refers to all activities internal to firm, which aims at fulfilling demand generated by SRM in a timely and cost effective manner (Chopra and Meindl, 2014). Further, the authors highlighted that CRM is the interface between customer and firm, which aims at making customer order and tracking them. It is vital to implement SCM as a part of a process orientation (Croxtton et al., 2001). Leading fashion retailers such as Vitoria Secrets in apparel industry had utilized SCM process in order to achieve service excellence (Kumar, 2005). The process comprised supply-side business processes, inside business processes and customer-side business processes.

2.4 Supply Chain Management in Apparel Industry

The supply chain of apparel industry is dispersed creating physical distances between the players of the supply chain caused by increased globalization (Kumar, 2005). Hence, companies in apparel industry had started to find new means to enhance supply chain partnership through information integration and collaboration (Kumar, 2005). Nevertheless, the social unrest in supply chains has grown over the period in which Cambodia, Bangladesh, India, Indonesia, China and Sri Lanka had taken a significant proportion (J. Safra Sarasin Ltd, 2014). Further, international brand such as Asics, Nike and Adidas are leveraging apparel producers with guidelines and management systems to optimize supply chains and to overcome the challenges. Moreover, brand such as Victoria secret stores, Victoria secret direct, Bath and body works and Express under Limited Brands, an American fashion retailer had implemented vigorous measures to ensure the effectiveness of supply chains (Kumar, 2005). Hence, supply chain management is identified as one of the important aspects affecting business performance in in apparel industry.

Based on the above literature findings, this study has developed conceptual model to assist empirical investigation. The conceptual model comprises of three key elements, i.e. (1) supply chain management processes (SRM, ISCM and CRM), (2) parties involved (internal parties, upward parties and downward parties), and (3) flows (information flow, service/ product flow, finance flow). The model is shown in Figure 2.

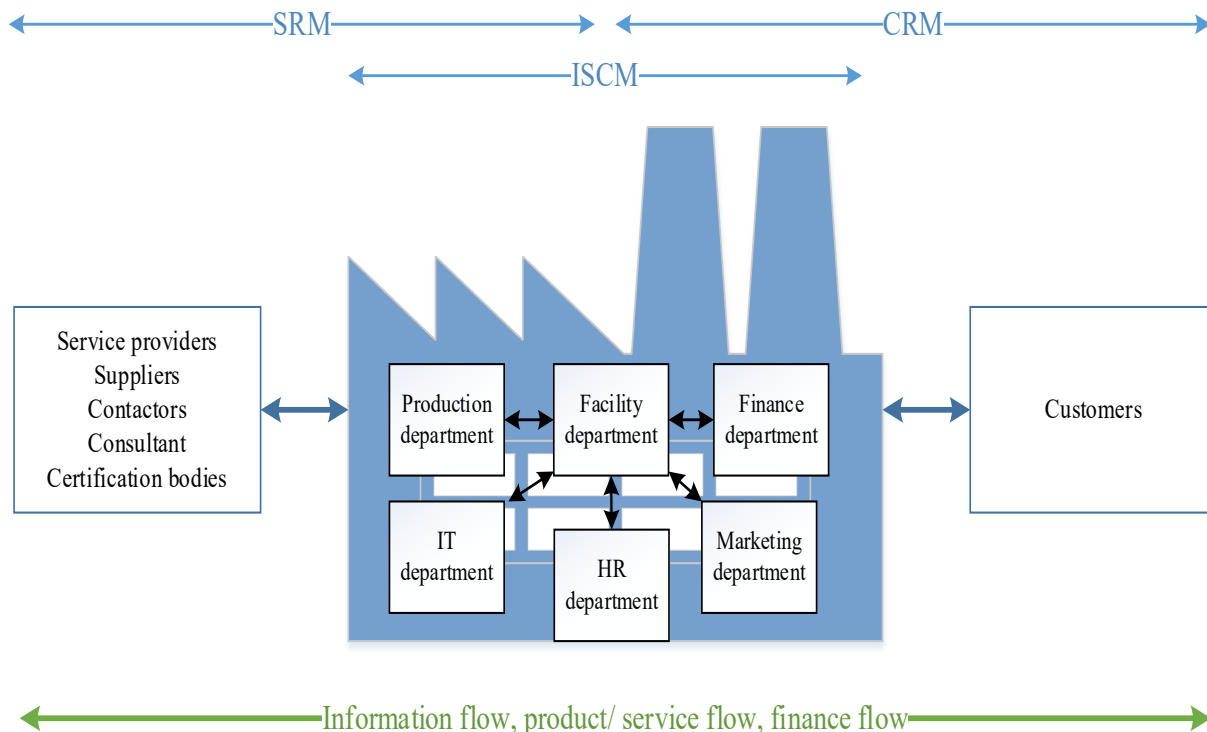


Figure 2: Conceptual Framework

3. Research Methodology

The study was aimed to develop a model for managing supply chain of facility O&M function in apparel sector. Initially a detailed literature review was undertaken to review evolution of maintenance approaches, operation and maintenance function of a facility and its supply chain, supply chain management and supply chain management in apparel industry. Subsequently, qualitative research approach was deployed for data collection due to the necessity of in-depth information. The research design was based on multiple case studies under qualitative approach as the researcher required multiple sources to validate the findings of the study. Three case studies covering apparel manufacturing factories of three leading apparel organisations were selected for the study. The data collected through interviews, observations and document review was analysed using manual content analysis and QSR N-Vivo software. The multiple data collection platforms of unstructured interviews, observations and document reviews had established the validity of the findings through data triangulation. The case study profile is presented in Table 2.

Table 2: Case Study Profile

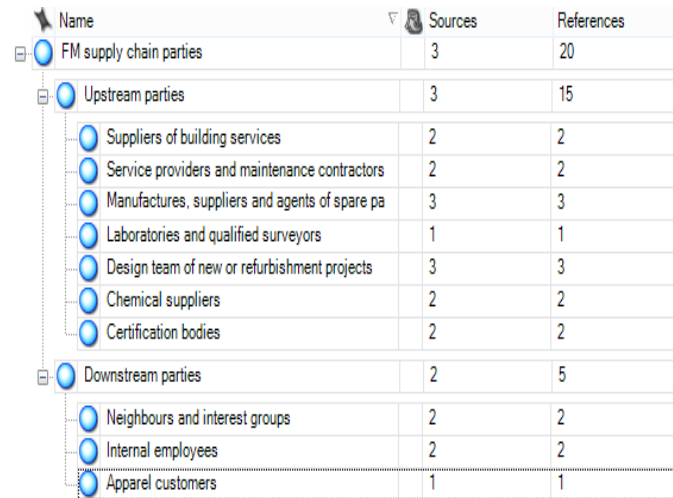
Case Description	Case A	Case B	Case C
Ownership of the organisation	Privately owned	Privately owned	Privately owned
Core business	Apparel Manufacturing	Apparel Manufacturing	Apparel Manufacturing
Products manufactured	Sportswear- jockstrap and sports bra, shorts, track suits	Casual wear- cargo pants, woven bottoms, basic pants, 5- shorts and skirts, pocket jeans	Knit garments, including shorts, dresses, pants, skirts, blouses, nightwear and children's wear
Customers	Nikie, Lulu Lemon, Patagonia, Columbia, Calvin Klein	Marks & Spencer and GAP	Levi's, Marks & Spencer, Tesco, Lauren, True Religion, Ralph and Tommy Hilfiger.
Standards complied	ISO 140001, OSHAS 18001, ISO 9001, ISO 5001	ISO 140001, OSHAS 18001, ISO 9001, ISO 5001	ISO 140001, OSHAS 18001, ISO 9001, ISO 5001
Number of employees	2000	1200	3000

4. Research Findings and Discussions

O&M is among the utmost important functions in all three factories. A dedicated team under chief factory engineer had been appointed in all three factories in order to meet maintenance requirements and ensure functionality of the buildings and equipment. Established maintenance process and procedures were witnessed in all three case studies of A, B and C. Corrective maintenance, which is a first generation maintenance approach backdated before 1950 according to is still in practice in all three factories at a limited degree. Preventive maintenance originated in 1950s was practiced in plants at a greater degree. Predictive maintenance and computerized maintenance practices had been implemented in the factories but still at infancy stage. However, several supply chain management practices were identified in all three cases by means of interview, observations and document review. *Maintaining a list of maintenance contractors ranked based on performance at divisional or corporate levels, maintaining proper service agreements among contractors and organizing trainings for technicians in collaboration with equipment suppliers* are commonly agreed practices in all three cases. Hence, supply chain management is not a first-handed concept to the industry but the lack of established practices throughout the supply chain had missed organizations the opportunity of acquiring long term synergies within the process. Therefore, establishing the facility O&M supply chain management process is paramount to sustain long term economic advantages.

In order to establish facility O&M supply chain the parties involved in facility O&M has to be determined. Chief factory engineer from case A, identified manufactures of machinery and equipment, suppliers of spare parts, chemicals, building services, service providers and maintenance contractors as main parties involved in upstream whereas chief factory engineer from case B identified laboratories and qualified surveyors, chemical suppliers, design team of new or refurbishment projects and certification bodies and chief factory engineer from case C identified manufactures, suppliers and agents of spare parts, machinery and equipment, service providers and maintenance contractors, suppliers of building services, laboratories and qualified surveyors and chemical suppliers as main parties

involved in upstream. At downstream respondents from case A and B identified internal employees, B and C identified neighbours and interest groups and C added on apparel customers. When observing the process in the case study such as complaints handling these parties involvement were witnessed. Further, through the documents such as maintenance contracts, standard operating process documents, invoices, audit reports the identified parties involvement in O&M were further identified. Accordingly, the main parties at upstream and downstream of the supply chain were analysed using N-Vivo software and is demonstrated in Figure 3.



Name	Sources	References
FM supply chain parties	3	20
Upstream parties	3	15
Suppliers of building services	2	2
Service providers and maintenance contractors	2	2
Manufactures, suppliers and agents of spare pa	3	3
Laboratories and qualified surveyors	1	1
Design team of new or refurbishment projects	3	3
Chemical suppliers	2	2
Certification bodies	2	2
Downstream parties	2	5
Neighbours and interest groups	2	2
Internal employees	2	2
Apparel customers	1	1

Figure 3: Parties Involved in Upstream and Downstream of Facility O&M Supply Chain

The study subsequently developed a model for managing supply chain of facility O&M function in apparel sector by incorporating case study finding under three key elements, i.e. (a) supply chain management processes (SRM, ISCM and CRM), (2) parties involved (internal parties, upward parties and downward parties), and (3) flows (information flow, service/ product flow, finance flow). The model is shown in Figure 4 and describes the supply chain of facility O&M function of apparel factories. The external customers and suppliers had been clearly demarcated in Figure 4. However, when determining the internal customers and suppliers it was evident that the internal departments act as internal customers and internal suppliers to maintenance department thereby play a dual role. According to chief factory engineer of case C, Human Resource (HR) department could supply maintenance department with required human resource and act as a supplier at another instance when maintenance department rectify any maintenance defect complained by the HR department the HR department becomes a customer of maintenance department. Hence, a dual role is played by the departments. Respondent from case A highlighted that an external supplier could have a direct relationship with maintenance department, finance department or HR department. Chief factory engineer from case B noted that it is most unlikely that external suppliers related to facility O&M to have a direct relationship with production related departments. According to the opinion of respondents, the external customers of maintenance supply chain does not have a direct relationship with maintenance department rather have an indirect relationship through HR department. Client who is the factory owner remains on top of the process and overseas the entire chain. These were further evident during document review of complaints.

Respondents in case A, B and C agreed with the information categories identified in literature and further splitted the categories of information in to upstream and downstream. Accordingly at upstream physical information involved were client requirements, equipment and system operating parameters, warranties, inspection and maintenance schedules, recommendations of tests and surveys, maintenance and cleaning products and tools and spare parts information, specifications and terms and agreements; Legal information involved were zoning and building codes and safety and environmental regulations and Financial information were on lease or operating revenue, depreciation schedules and operations and maintenance costs. At the downstream information identified were on requirements of maintenance, repair and refurbishments, maintenance activity progress, emergency response requirements and complaints. In terms of product and services flows at upstream, spare parts, maintenance services, consultancy, equipment, lubricants, cleaning materials and construction materials were identified. These services and products extends to downstream level until the final customer requirements are met. The used products such as e-waste are return back to suppliers for recycling process hence, the product and service flow acts bidirectional. The finance flow

at upstream involves payments made for spare parts, test and surveys, consultancy, maintenance and renewing certificates. At downstream compensations provided to neighbours or internal employees due to negligence of the maintenance team was accounted as cash outflow. Hence, finance flow become bidirectional in nature. However, when managing the O&M supply chain one should note that the internal supply chain plays a vital role. In order to ensure that the products service obtained at upstream level reaches the downstream customer internal supply chain of facility O&M plays a significant part. The above identified information categories, finance and service flows were further evident during the document review of maintenance contracts, service agreements, audit reports, invoices and other specific documents related to O&M. The process the information flow, finance flow and service/ product flow in relation to facility O&M has been presented in Figure 4. While the upstream of the function and internal supply chain process has a serious impact on downstream, the management of downstream affairs are paramount to ensure service excellence throughout the supply chain. Hence, managing the O&M SCM process is vital.

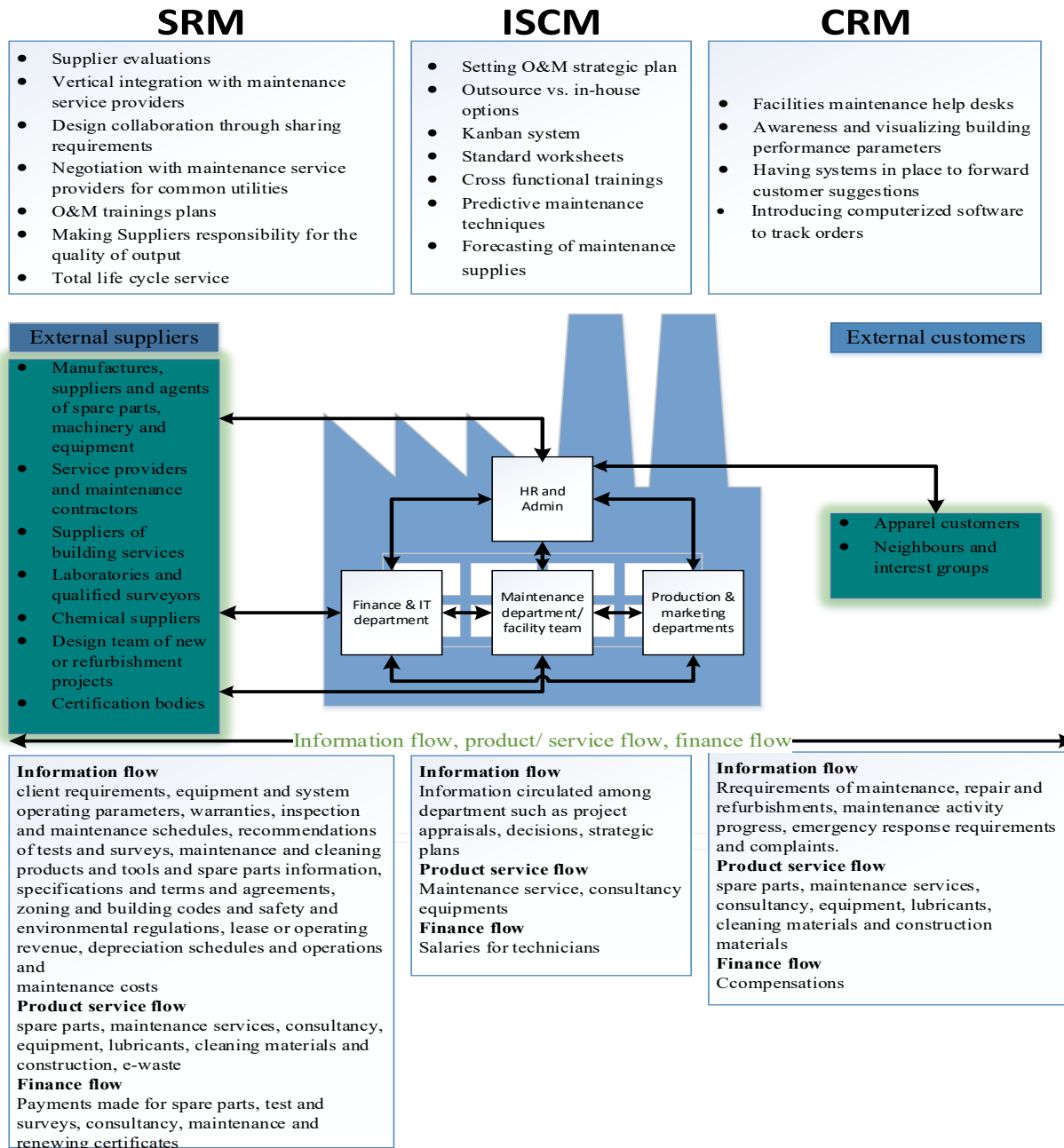


Figure 4: Supply Chain Management Model for Facility O&M Function in Apparel Sector

The sub three process identified in the study under supply chain process has been incorporated in Figure 4 as SRM, ISCM and CRM. The findings derived from case study A, B and C has been summarised and described below.

Supplier Relationship Management is a vital element in ensuring a seamless service delivery for end user involved in O&M. Respondents from all three cases agreed that the sub components of SCM process comprises several sub categories as *Design collaboration, Source, Negotiate, Buy and Supply collaboration*. The concept of *Design collaboration* could be implemented to O&M by sharing safety requirements and other technical requirements with customers and getting the required output from suppliers itself. This will enable to obtain suppliers involvement in meeting apparel customer requirements and gain expertise in areas where internal experts are not available. Carrying out supplier evaluations and ranking them based on several performance criterion such as quality, on time delivery before selecting suppliers could be implemented as a strategy in implementing the sub category *Source*. *Negotiation* been an important element could be applied in facility O&M through forming agreements for common utilities at enterprise level and handing over contracts to few parties preferable two parties (one as backup), who could meet maintenance requirements. *Buy*, ensuring proper systems are in place to procure and place orders. *Supply collaboration* aids in developing common plans throughout the supply chain, which could be applied to O&M through developing O&M trainings plans where manufactures of equipment provide technical trainings to technicians and safety trainings provided for representatives of manufactures on site by authorized parties. Making suppliers responsible for the quality of the output of the product sold (eg. Chemical suppliers of effluent treatment plant are paid for the quality of effluent output not the chemicals used by them to take the output) and suppliers made responsible for the life time of the product supplied (eg. Bulbs recycled free of charge) are few other methods for supplier collaboration.

Internal Supply Chain Management of O&M in a factory setting comprise mainly the maintenance department and other departments, which work collaboratively in order to meet customer requirements. *Strategic planning, Demand planning, Supply planning, Fulfilment and Field service* are the key parameters identified under Internal Supply Chain Management. O&M does not operate detached from organisational strategy any more. In fact is a key contributor in maintaining organisational targets and a seamless process. *Strategic planning* is therefore highly applicable to O&M in factories. This includes on determining the O&M objectives, determining strategies to meet objectives, analysing and evaluating options to meet the strategies and planning for implementation. However, respondents stressed the importance of factories planning to achieve zero defects. Introducing predictive maintenance techniques so that any maintenance requirements could be predicted before occurring of a breakdown was agreed by many respondents as means of *Demand planning*. Further, forecasting spare parts requirements and the requirements of other auxiliary items (lubricants, fuel, oil and cleaning) were noted by respondents under demand planning. *Supply planning* in O&M could be achieved through reviewing user manual and determining maintenance process and procedure in order to define services to be outsourced and undertaken internally, use of Kanban system to allocate available internal technicians among the maintenance requirement systematically, developing standard worksheets to enable a non-technical person to carry out emergency maintenance service during a shortage of labour and carrying out cross functional trainings so that expert in particular field would able to get involved in other technical areas and support other technicians. *Fulfilment* involves the process of meeting the demand. In manufacturing it is the process of linking customer order to supply source and means of transportation. In O&M the Kanban system could be utilized for the fulfilment as it maps the maintenance requirement to the source, technicians or external service providers. *Field service* in O&M is not a onetime process it is continuous as customers at most instances receives maintenance services. The Facilities Manager or Maintenance Manager should have a good track of it.

Customer Relationship Management refers to satisfying the O&M customer expectations by meeting customer requirements. *Marketing, Sell, Call centre and Order management*, which were the main sub components under CRM could be applied to O&M. According to the respondents' opinion, marketing and selling could be done through displaying recommended building performance parameters (temperature, lux levels) and actual parameters in order to make internal customers aware and market the performance of maintenance team. Implementing facilities management help desks could align with the *Call centre* option whereas creating a platform between customer and suppliers of O&M through the application of software to facilitate the process of mapping the extent of meeting customer requirements by internal and external suppliers of O&M services and products would facilitate in meeting *Order management*.

5. Conclusions and Recommendations

Facilities operation and maintenance is something unavoidable in current context and especially in apparel manufacturing facilities. Starting from the external fabric up to utility services determine the quality of work environment and ensures the continuous production process within the facility. For instance a breakdown in compressor would hold the entire sewing process and would impact the targeted output. Hence, O&M is paramount for apparel factories. Yet, no factories focus on streamlining its supply chain and determining a practicable O&M supply chain process. As a result, synergies, which could be gained in the process is neglected. This could be overcome by initially determining the O&M supply chain and establishing the supply chain process. This study had made an effort in determining both, which would contribute to industrial practitioners in long run. The O&M maintenance supply chain is a chain of networks, which is made of internal customers, external customers, internal suppliers and external suppliers along with interrelated information flows, finance flows and service/product flows. Further, the O&M supply chain involves direct and indirect relationships among multiple parties creating several challenges such as improper coordination, not meeting customer requirements, long waiting time, lack of spare parts, and more. In order to address such challenges incorporating SCM process is necessary. The developed O&M-SCM process mainly comprises three sub process as CRM, ISCM and SRM. In order to ensure the implementation of such sub processes several strategies were introduced through the study. The developed O&M supply chain and the O&M-SCM process could be utilized by facilities managers, maintenance engineers and other professional engaged in similar disciplines to ensure a seamless service delivery to meet end customer requirement and in long term add on to organisational profit. This study had made an effort in determining both, which would contribute to industrial practitioners in long run. The study will be further developed to establish a performance measurement system to enhance effectiveness and efficiency of FM supply chain.

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