A Review of the Role of Maintenance and Facility Management in Logistics

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Alberto De Marco, Giulio Mangano

***Abstract*— Facility Management (FM) is a discipline involving a variety of non-core operations and maintenance services to support the main business of an organization. This paper aims to provide an overview on the different ways of carrying out FM and related topics, in order to uncover that there is limited research regarding the impact of FM actions on the logistics and operational performance of distribution centres and warehouses. Four different focus areas have been identified and for each one different methodologies and streams of research are studied. The analysis highlights the importance of FM for the logistics activities and underlines the need for performing research, since very few studies have explored the relationship between FM strategy, maintenance actions and performance of logistics businesses.**

***Index Terms*— Facility Management, Maintenance, Logistics**

I. Introduction

The Facility Management (FM) function has been gaining increasing recognition for the important role it can play to create cost savings and efficiency of the workplace. The primary task of FM is to manage support services to meet the needs of the organization, its core operations and employees. It deals with the maintenance management of the physical assets and incorporates controlling services necessary for successful business [1]. As a coordinated and structured activity, FM has been being successfully applied to maintaining and operating diverse types of constructed facilities in many sectors. FM has also been being applied to industrial facilities, with an extended share in logistics and warehousing. In this particular context, maintenance plays a significant role to assure the full service of the warehousing system, which includes both building components and equipment. In its narrow meaning, maintenance involves all activities related to maintaining a certain level of availability and reliability of a system and its components, and its ability to perform to a standard level of quality. More generally, by implementing a FM function, companies might be able not only to optimize warehouse maintenance expenses through appropriate maintenance, but also to contribute to effective logistic operations and higher return on investment.

However, many companies complain about the increasing cost of maintenance of industrial and logistic facilities and seek to cut FM spending by reducing repair interventions to a minimum and delaying preventive maintenance actions, which in turn lead to a cascade of extra costs in the medium and long term [2]. It seems difficult for organizations to perceive the level of FM spending as a crucial logistics business success factor and maintenance does not receive enough management attention because of the belief that the associated costs cannot be easily controlled [3].

Many studies are available to analyze diverse aspects of the FM discipline, mainly in the areas of FM strategies and actions, key performance indicators (KPI), maintenance and operations, and contracting/outsourcing of the FM duty, and some of these works are specifically addressed to logistics and warehousing. However, little analysis has been carried out to investigate the relationship between FM and maintenance with the performance of the logistic business.

The aim of this paper is to provide a literature review centered around the area of FM for industrial facilities and associated topics, in order to uncover that there is limited research regarding the impact that a well designed and well operated FM function can have on logistics and operational performance of warehouses. The given literature review aims at bringing out this lack of research, based on the proposition that a link between FM and business KPIs could be a promising area of unexplored business performance improvement. The objective is to suggest FM managers that they can effectively contribute to enhance business performance by designing proper FM strategies, assuring appropriate FM contract modes, and implementing effective maintenance actions.

The paper is structured as follow. First, the FM discipline has been subsumed into four main focus areas, namely “Performance measurement of Facility Management”, “Warehouse Maintenance”, “Performance Measurement in Logistics Operations”, and “FM Contracts”. For each focus area, a literature review has been carried out in order to identify the main research streams and methodologies. Then, we propose an analysis of the literature and, finally, implications and conclusions are drawn together with future research directions.

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A. De Marco is with the Department of Management and Production Engineering at Politecnico di Torino; (e-mail: alberto.demarco@polito.it).

G. Mangano is with the Department of Management and Production Engineering at Politecnico di Torino, phone: +39011090705; (e-mail: giulio.mangano@polito.it).

II. Performance Measurement of Facility Management

The FM discipline has emerged out of practice because of a clear need to focus on the elaborate and expensive facilities that crucially support the activities of most businesses. It is a distinctive part of the overall management function focused on the workplace. FM can be sees as an integration of three main strands of activities: property management, property operations and maintenance, and office administration [4].

FM services were first provided in the 1960s in the USA and they were fully developed in 1970s. But it was only in the 1980s that such a FM market developed in Europe [5]. FM processes as well as management practices are the same all over the world, while different normative constraints have to be handled in different countries. The activities that might be carried out within FM are mainly connected to building facilities and auxiliary activities. In particular, they include building maintenance and management, maintenance of HVAC and energy sources, gardening, surveillance, cleaning, logistics, etc [6].

FM works at two levels; on the one hand, it provides a safe and efficient working environment, which is essential to the performance of any business. On the other hand, FM can involve several strategic issues such as property portfolio management, strategic property decision, and facility planning and development, which are related to policy and strategic planning of the organization [7].

FM should aim not only to simply reducing the operating expenses of a constructed facility, but also to enhancing efficiency of the facility as well [1]. To gauge the effectiveness of FM, it is necessary to reach an understanding of the current conditions of the facility and to postulate change in FM practices in order to achieve the desired performance. As a matter of fact, FM is developing into an important corporate discipline; increasing numbers of organizations are linking their everyday business performance to their method managing their facilities and workplace assets [8].

The revolution of performance measurement has spread into many disciplines, including FM. Reference [9] investigates KPIs for the performance of maintenance in healthcare facilities that are classified into four main categories: development, organization and management, performance and maintenance efficiency. Basically, the idea is that FM must include quantitative KPIs. Thus, performance metrics is an important step in the process of performance evaluation as it includes relevant indicators that express the performance of the facility. Therefore it is of crucial importance to identify a set of KPIs to establish effective performance evaluation metrics for the facility under consideration [10]. KPIs are parameters that focus on critical aspects of outputs or outcomes. In recent years we have observed the introduction of KPIs in the FM discipline, such as loss of business due to failure in service, provision of project to customer satisfaction, provision of safe environment, effective utilization of space, effectiveness of communication, service reliability, professional approach of staff , responsiveness of problems. Furthermore they can be incorporated into FM contract specifications and documentations, communicating clear expectations of desired outcomes and how they will be monitored and controlled [11].

Reference [1] proposes a list of KPIs arranged under the following categories:

- - financial indicators, which relate to costs and expenditure, associated with operation and maintenance, energy, building functions, real estate, plant, etc;
- - physical indicators associated with the physical shape and conditions of the facility, buildings, systems, and components;
- - functional indicators, related to the way the facility and the buildings function and which express building appropriateness through space adequacy, parking etc,
- - survey-based indicators, which are based solely on respondents' opinion to surveys that are primarily qualitative in nature.

Reference [12] underlines how, according to the respondents of his survey, FM organizations, benefit from effective performance measurement. The aim of his research is to demonstrate that the proper selection of performance indicators is important for the improvement of FM performance. Performance measurement is accepted by the vast majority of FM practitioners and organizations as a management strategy, because they have realized the importance of performance measurement to their business success. In particular the four main benefit are client focus, value for money, high standard of service delivery, tender selection based on performance. According to FM professionals involved in the survey, it is important to choose proper KPIs, in order to avoid ineffective measurement and misleading of the performance. The ten most important KPIs identified by the respondents are client satisfaction, cost effectiveness, response time, service reliability, health, safety, environmental compliance, staff commitment, client-service provider relationship, and IT application.

Poor FM could result in inadequate facilities to support functioning, not contributing to the organization's mission, cost inefficiencies, inadequacy and unavailability of the facility for future needs. On the contrary, a strong FM approach provides needed support to the organization's mission for the realization of future facility requirements, greater cost efficiency and the ability to anticipate results of current management decisions [1].

III. Performance Measurement in Logistics Operation

Logistics operations are responsible for the efficient and effective handling of goods and services with the ultimate aim to minimize any costs, to improve customer service and to create a competitive advantage [13]. Reference [14] defines logistics management as "that part of Supply Chain Management that plans, implements, and controls the efficient, effective forward and reverse flow

and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements".

Logistics performance encompasses multiple service metrics, such as lead time and on-time delivery, which are related to each other. The purpose is to monitor, control and direct logistics operations. In any case merely measuring logistics performance has no value. The central objective of measurement is to enable improvement of customer service in the direction of customer's requirements. The customers' needs are about increased expectations on lead time inventory availability and availability of delay information and accurate order [15] .

To be able to continuously improve logistics performance, a number of activities preceding measurement are necessary. Reference [16] shows that the measures in logistics are essential for an effective management of the operations inside a company.

Logistics performance is often related to delivery service, logistics cost and tied up capital. Delivery service can be split up and measured as lead-time and on time delivery [17]. Reference [18] focuses her attention on quick response, that is considered a key strategy to apply in logistics and it is based on electronic devices such electronic data interchange, bar coding, electronic points of sale and lasers scanners to immediately track customer sales.

Reference [19] classifies the measures into two main groups: financial measurement methods that encompass budgeting techniques, cost estimating, mission costing, and engineered physical measures such as productivity, lead times, quality, and customer service.

Logistics performance is positively impacted by supply chain management strategy and directly impacts marketing performance which in turn, impacts financial performance [20]. Developing logistics service innovation can be what sets a firm apart and improves performance and the appropriate structure may enhance innovation capability [21].

Logistic Service Providers (LSPs) should measure their performance based on five strategic resources (physical, human, information, knowledge and relational resources) in order to achieve competitive advantage [22]. Physical resources include tangible assets required to perform logistic tasks. They are logistic centres, hubs, vehicles and aircraft. Human resources are referred to as workforces who are skillful and experienced in performing logistics tasks and building up and maintaining customer relationship. Knowledge resources are the abilities to gaining access to rare resources and relational resources are meant as the abilities to build up long-term working relationship with key suppliers and customers.

The pressure on LSPs in operating business is getting heavy due to the continuous increase in demand of clients [23]. It is therefore for logistics service providers to formulate business strategies in order to keep distinctive competitiveness advantage in such a changing market environment [24]. Furthermore it is always a challenge for logistics strategy planners to develop a series of strategies integrating the facilities. These actions involve facility design and material handling, distribution and service facilities, facility layout. In this way it is easy to align with the clients' logistic strategies.

IV. Maintenance of Warehouses

Today's successful warehouse operations view maintenance as a top priority to ensure maximum utilization of both facility and equipment assets, and companies have been actively looking at various ways of manage maintenance activities [25]. Effective warehouse maintenance practices must become part of the warehouse strategic master planning process. The scope of warehouse operations in terms of size, location and type/number of equipments dictates whether the maintenance plan has its own in-house maintenance service or depends more on outsourced contracting. Regardless of the source of repair, two responsibilities of warehouse maintenance must be achieved: safe and reliable operations of material handling equipment and maintenance of warehouse facilities, grounds, utilities, plumbing, heating, air conditioning, fire protection, security system and so on [26]. Facility managers are forced to consider the business implications of their actions before maintenance programs are developed and provide feedback mechanisms to monitor the impact of any action against key business drivers [27].

Built asset maintenance is often viewed as a cost burden [28], and organizations are typically reluctant to spend in order to preserve the condition of their assets [29]. In addition, just recently maintenance has been recognized as a potential profit generator. In fact, maintenance should be viewed not as a source of cost, but rather as a way for potential gain [30].

Reference [31] shows that manufacturing companies, by strategic maintenance development, may achieve substantial improvements of their business productivity.

Therefore, measuring maintenance performance appears to be very important: this is a complex task since multiple inputs and multiple outputs are involved in the process [32]. The approaches to measuring the maintenance and FM performance can be mainly subsumed into three types, namely balanced scorecards, system audits, and value-based assessment. The Balanced Scorecard provides an alternative and holistic approach to measurement which is developed on the idea that no single measure is sufficient to indicate the total performance of a system. It is based on a panel on measures such as response time, service commitments, and customer satisfaction [33]. System audits give an approach to predict future maintenance performance with particular focus on interactions between the social system in the organization and its operating environment [34]. The value-base attempts to assess the impact of maintenance activities on the future value of the associated asset is a financial indicator focused on the future cash flows [35].

By identifying the true strategic goals of maintenance and by implementing a well-formulated strategy,

companies can optimize the return on investment of their maintenance expenditure [31]. In order to evaluate the fulfillment of the strategic goals KPIs have to be set. Also data collection methods and contractual responsibilities may be defined in a strategy formulation. In this way organization can identify which factors may potentially influence the gap between current and desired level of performance. Maintenance is an activity that is often relied on an external supplier; the relationship between the client and the maintainer is set on a contract. Therefore, the contractual scheme has to be much clear as possible in order to avoid any kind of disputes among the involved parties and maximize their satisfaction.

V. Facility Management Contracts

As described above, the FM function covers an extremely wide range of activities, including workplace maintenance, support services, property, corporate real estate, and infrastructure. FM is often performed by a service provider, but many logistics companies still carry out a mix of in-house repair and contracted FM services: some maintenance operations are executed by the warehouse personnel, while other tasks are handled by FM contractors, especially in case of actions requiring specialized equipment or trade skills. However, there is an overall tendency to also outsource the portion of work that was previously done in-house [36].

As an outsourced service, FM requires the contractor's time and resource commitment to avoid escalation of cost and risks. Moreover, without a long term partnership between maintenance service supplier and the user, the supplier will be hesitant to invest in staff development, equipment and new technologies [37]. Optimized maintenance activities in long term outsourced partnering contracts can be used as key factors to improve business efficiency and effectiveness [38]. However, managing and controlling FM operations, performance and risks in long term partnerships, as well as modeling and understanding their cost, is still a significant challenge [39]. Until recently there was no standard form of contract for building service operations and maintenance (O&M) work, and many maintenance contracts were loosely formed. The irregularities or inadequacies in such contracts have led to disputes that jeopardized contract performance [40]. Reference [31] shows that companies involved implemented relevant KPIs, based on specific strategic goal and in a longer perspective, target value are to be incentives for parts of the contract costs. The main KPIs that have been identified are work time distribution in percentage between preventive maintenance and corrective maintenance, overall equipment effectiveness and technical availability.

The potential benefits of outsourcing maintenance activities includes less hassle, reduced total system costs, better and faster work done, exposure to outside specialists, greater flexibility to adopt new technologies and more focus on strategic asset management issues [41].

Diverse interpretation of contract terms between the contracting parties would give rise to disputes, which may lead to suspension of work and high costs for both parties, including the costs for resolving the disputes and compensation of losses to the other parties. Proper use of terms of contracts requires clear definition of contractual responsibilities and means to deal with unexpected situations [36].

VI. Critical Analysis

Some authors have already underlined the link between FM management actions, especially maintenance, and the performance of the overall business. FM can be summarized as creating an environment that is conducive to carrying out the organization's primary operations, taking an integrated view of the services infrastructure, and using this to deliver the enhancement of the core business [42]. Reference [43] proves that strategic use of customer performance measurement processes can enhance the provided FM services. Reference [44] figures out the elements that can improve performance for a FM service provider. In particular, the influence was recorded for inventory control and flexibility. In addition, it is underlined that new technologies identified to be used by LSPs, such as advance shipment notification, automated storage and retrieval systems, electronic data interchange, bar-coding, voice input services, can significantly contribute to improving business performance. Reference [45], through an international survey carried out among manufacturing companies, recognizes logistics performance as an important element for achieving competitive advantage in the future. Reference [46] shows a survey on the university building in Malaysia and it indicates that maintenance issues are considered as tactical rather than strategic. The case study proposed in reference [31], shows that the awareness of maintenance as a contributor to the company profitability has increased. At the same time, maintenance managers have worked hard to sell change initiatives. In particular, all the companies involved have decreased the downtime due to corrective maintenance, that is more expensive than the time used for preventive maintenance.

Reference [47] demonstrates that a few variables inherently associated with the operational characteristics of the logistics business are significant factors in improving the logistics service level. In addition, maintenance cost is a significant driver of the logistics service level performance. Therefore, building components can be maintained not only to preserve the functional and the economic value, but also to assure the conditions for running a competitive business. Thus, it is very important to investigate the factors of maintenance cost in warehouse facilities in order to avoid ineffective and expensive managerial practices. Reference [2] shows that geographical location, the monthly rental fee and freight traffic volumes are significant factors of the maintenance warehouse costs.

Reference [48] identifies the most important drivers affecting the decision to outsource maintenance services in Saudi Arabian Universities; the most important three factors are identified as "increase the speed of implementation", "improve quality requirements", and "risk sharing with contractors". No coincidence outsourcing is widely viewed to be an effective opportunity for organizations to reduce expenditures, free-up capital resources, improve service quality and focus on primary activities.

Finally, it can be argued that the FM function is constantly changing. In the near future, FM providers are expected to be a part of delivering on environmental commitment. Due to their knowledge of building services and their capability of bringing about change internally, the linkage between FM and environmental issues in logistics and warehousing is likely to become a successful partnership. However, reference [49] underlines that sustainable business practice is not yet completely embedded into the FM industry, and sustainability is just beginning to play more of an influential role, especially among the larger companies. What is needed now is a greater understanding of the driving and restraining forces for sustainability involved in the FM function applied to warehousing operations. This shows that the more developed view of FM is an integrated approach to operating, maintaining, improving and adapting the building and the infrastructure in order to create an environment that supports the primary objectives of an industrial organization [50].

VII. Implications and Conclusions

In this paper a review of the main components of the FM discipline is carried out. The aim of FM is the improvement of the facility and the workplace: that is why more and more organizations are connecting their operational performance to FM actions. In particular, improved logistics performance via better FM and maintenance services can be a significant factor to achieve enhanced and continued competitive advantage. For many years FM and maintenance have been viewed as a unavoidable burden, but recently the awareness that FM and appropriate maintenance strategies can generate profit and significant savings is growing (Sherwin,2000). This is why companies are urged to change their operational paradigms towards an approach to monitoring and control the integrated effect of FM practices and maintenance on business performance.

In this sense, maintenance is called to be not only responsible for the safety and the reliability of the built assets and equipment, but also to become an important part of the strategic operational planning process of an organization.

This literature review highlights the importance of FM for the logistics performance and addresses the need to carry out research to explore their relationship because only very few studies so far considered the relationship between maintenance, FM practice, and logistics performance. This topic is brought to attention of both scholars and practitioners especially in this period of bad economy, when cost savings appear to be key sources of competitive advantage.

References

[1] S. Lavy, J.A. Garcia, and M.K. Dixit, "Establishment of KPIs for facilities performance measurement: review of literature", *Facilities*, vol. 28, no. 9/10, pp. 440-464, 2010.

[2] A. De Marco, S. Ruffa, and G. Mangano, "Strategic factors affecting warehouse maintenance costs", Journal of Facilities Management, vol. 8, no. 2, pp. 104-113, 2010.

[3] H. Lofsten, "Management of industrial management- economic evaluation of maintenance policies", *International Journal of Operations & Production Management*, vol. 16, no. 6, pp. 568-572, 1999.

[4] D. Kincaid, "Integrated Facility Management", *Facilities*, vol. 12, no. 4, pp., 20-23, 1996.

[5] A. Salaris, "Facilities Management opportunities", *Quaderni Edilforma*, Rome, 2002.

[6] A. Ancarani and G. Capaldo, "Supporting decision-making process in facilities management service procurement: a methodological approach", *Journal of Purchasing & Supply Management*, vol. 11, pp. 232-241, 2004.

[7] S. Chotipanich, "Positioning Facility Management", *Facilities*, vol. 22, no. 13/14, pp. 364-372, 2004.

[8] F.TY. Edum-Fotwe, C. Egby, and G.F. Gibb, "Designed Facility Management needs into infrastructure projects: case for a major hospital", *Journal of Performance of Constructed Facilities*, vol. 17, no.1, 2003.

[9] I.M. Shohet, "Key Performance Indicatorsfor strategic healthcare facilities maintenance", *Journal of Construction Engineering and Management*, vol. 132, no. 4, pp. 345-352, 2006.

[10] J. H. Cable and J.S. Davis, "Key Performance Indicators for Federal Facilities Portfolios", *Federal Facilities Council Technical Report 147*, National Academic Press, Washington DC, 2004.

[11] M. Loosemore and Y.Y. Hsin, "Customer-focused benchmarking for facilities management", *Facilities*, vol. 19, no. 13/14, pp. 464-475, 2001.

[12] X. Meng, "Performance measurement models in facility management: a comparative study", *Facilities*, vol. 29, no.11/12, pp. 472-484, 2011.

[13] M. Christopher, "Logistics and Supply Chain Management", *Financial Time*, London, 2006.

[14] Council of Supply Chain Management Professionals (2007), "Supply Chain Management and logistics Management Definitions". Available: www.csmp.org/Website/aboutCSCMP/Definitiions/Definitions.asp

[15] H. Forsuld, "The impact of performance management on customers' expected logistics performance", *International Journal of Operations & Production Management*, vol. 27, no. 8, pp. 901-918, 2007.

[16] A. Gunasekerana and B. Kobu, "Performance measures and metrics in logistics and supply chain management", *International Journal of Production Research*, vol. 33, no. 2, pp. 57-78, 2007.

[17] H. Forsuld, "The size of a logistics performance measurement system", *Facilities*, vol. 29, no. 3 /4, pp.133-148, 2011.

[18] Z. Rouhollahi, "Logistics Philosophies", *Logistics Operation and Management*, pp. 89-107, 2011.

[19] P. Andersson, H. Aronsson, and N.G. Storhagen, "Measuring Logistics Performance", *Engineering Costs and Production Economics*, vol. 17, no. 1 /4, pp. 253-262, 1989.

[20] K. W. Green, D. Whitten, R. A. Inman, "The impact of logistics performance on organizational performance in a supply chain context", *Supply Chain Management: an International Journal*, vol. 13, no. 4, pp. 317-327, 2008.

[21] P. J. Daugherty, H. Chen, B.G. Ferrin, "Organizational structure and logistics service innovation", *The International Journal of Logistics Management*, vol. 22, no. 1, pp. 26-51, 2011.

[22] C. W. Wong and N. Karia, "Explaining the competitive advantage of logistics service providers: a resource-based view approach", *International Journal of Production Economics*, vol. 128, pp. 51-67, 2010.

[23] H. K. H. Chow, K. l. Choy, W.B. Lee, and F. T.S. Chan, "Design of a knowledge-based logistics strategy system", *Expert System with Application* vol. 29, pp. 272-290, 2005.
[24] T. H. Daventport, S. L. Javerpaa, and M.C. Beers, "Improving knowledge work processes", *Sloan Management Review*, vol. 37, no.4, pp. 53-55.
[25] J.D. Campbell, "Outsourcing in maintenance management: a valid alternative to self provision", *Journal of Quality in Maintenance Engineering*, vol. 1, no. 3, pp. 18-24, 1995.
[26] J. D. Smith and J. A. Tompkins, *Warehouse Management Handbook,*, Tomkins Press, Raleigh NC, 1998.
[27] K. Jones and M. Sharp, "A new performance-based process model for built asset maintenance" *Facilities*, vol. 25, no. 13/14, pp.525-535, 2007.
[28] D. Sherwin, "A review of overall models for maintenance management", *Journal of quality in Maintenance Engineering*, vol. 17, no. 1, pp. 5-25, 2000.
[29] M. Y. L. Chew, S.S. Tan, and K. H. Kang, "Building maintainability- review of the state of the art", *Journal of Architectural Engineering*, vol. 10, no. 3, pp. 80-87, 2004.
[30] F. Taillander, G. Sauce, and R. Bonetto, "Methods and tools for building maintenance plan arbitration", *Engineering, Construction and Architectural Management*, vol. 18, no. 4, pp. 343-362., 2011.
[31] A, Salonen and M. Bengtsson, M. "The potential in strategic maintenance development", *Journal of Quality in Maintenance Engineering*, vol. 17, no. 4, pp. 337-350, 2011.
[32] A. H. C. Tsang, A. K. S. Jardine, and H. Kolodny, "Measuring maintenance performance: a holistic approach", *International Journal of Operations & Production Management*, vol. 19, no. 7, pp. 691-715, 1999.
[33] R. G. Eccles, "The performance measurement manifesto", *Performance Measurement and Evaluation*, London: Sage Publication, pp. 5-14, 1995.
[34] R. A. Dwight, "Performance indices: do they help with decision making?", *in Proc. of ICOMS-94*, Sidney, 1994, pp. 1-9.
[35] R. A. Dwight, "Searching for real maintenance performance measures", *Journal of Quality in Maintenance Engineering*, vol. 5, no. 3, pp. 258-275, 1999.
[36] J H. K. Lai, F. W. H. Yik, and P. Jones, "Disputes arising from vaguely defined contractual responsibilities in building services maintenance contracts", *Facilities*, vol. 22, no. 1/2, pp. 44-52, 2004.
[37] H.H. Martin, "Contracting out maintenance and a plan for future research", *Journal of Quality in Maintenance Engineering*, vol. 3, no.2, pp. 103-118, 1997.
[38] W. Wang, "A model for maintenance service contract, design, negotiation and optimization", *European Journal of Operational Research*, no. 201, pp. 239-246, 2010.
[39] A. Neely, "Exploring the financial consequences of servitization of manufacturing", *Operation Management Research*, vol. 1, pp. 103-118, 2008.
[40] J. H. K. Lai, F. W. H. ,Yik, and P. Jones, "Critical contractual issues of outsourced operation and maintenance service for commercial buildings*", International Journal of Service Industry Management*, vol. 17, no. 4, pp. 320-343, 2006.
[41] U. Al- Turki, "Methodology and theory: a framework for strategic planning in maintenance", *Journal of Quality in Maintenance Engineering*, vol. 17, no. 2, pp. 150-162.
[42] B. Atkin and A. Brooks, *Total Facilities Management*. Oxford: Blackwall Publishing, 2002.
[43] M. Tucker and M. Pitt, "Customer performance measurement in facility management: a strategic approach", *International Journal of Prductivity and Performance Management*, vol. 56, no. 5, pp. 407-442, 2009.
[44] D. Power, M. Sharafali, M, and V. Bhakoo, "Adding value though outsourcing: contribution of 3PL services to customer performance", *Management Research News*, vol. 30, no. 3, pp. 228-235, 2007.
[45] A. Harrison and C. New, "The role of coherent supply chain strategy and performance in achieving competitive advantage: an international survey", *Journal of Operational Research Society*, vol. 53, pp. 263-271, 2002.
[46] A. A. Olanrewaju, M. F. Khamidi, and A. Idrus, "Validation of building maintenance performance model for Malaysian universities*", International Journal of Human and Social Sciences*, vol. 6, no. 3, pp. 159-163, 2011.
[47] A. De Marco and G. Mangano, "Relationship between logistic service and maintenance costs of warehouses", *Facilities*, vol. 29, no. 9/10, pp. 411-421, 2011.
[48] S. Assaf, M. A. Hassanain, A.M. Al-Hammad, and H, Al-Nehmi, "Factors affecting outsourcing decisions of maintenance service in Saudi Arabian Universities", *Property Management*, vol. 29, no. 2, pp. 195-212, 2011.
[49] S. Price, M. Pitt, and M. Tucker, "Implications of a sustainability policy for facilities management organizations", *Facilities*, vol. 29, no. 9/10, pp. 391-410, 2011.
[50] B. Nutt, "Infrastructure and facilities: forging alignments between supply and demand", in *Proc. of Future Property and Facility Management II, A Two-Day International Conference, University College London*, London, 2004.