
THE INTEGRATION OF ENTERPRISE ASSET MANAGEMENT AND THE SUPPLY CHAIN

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ABSTRACT

This study was born out of the author's hands-on experience of pioneering the integration of Enterprise Asset Management (EAM) and the Supply Chain (SC). This first happened during a project undertaken as Project Manager during 1999 – 2000 in which there came an understanding of the relationship between the two disciplines, which now forms the basis of this thesis.

A supply chain is the movement of materials in response to the demand for a product. The traditional supply chain consists of five functions namely Buy, Move, Store, Make, and Sell. This is a perfect fit for a production environment. With supply chains has come the need to manage and optimise them. This discipline is called Supply Chain Management (SCM) and is about ensuring supply meets demand. Supply chain management has become a vital aspect for companies striving to improve their competitive edge and profitability and the number one strategic priority for manufacturing executives.

Enterprise asset management is the discipline of improving the Return On Investment (ROI) and Return On Assets (ROA) of capital-intensive assets through their effective and efficient management. Companies seldom have the opportunity to apply asset management in the planning, acquisition, installation, and disposal phases of an asset's life cycle. Due to this EAM has become associated with the maintenance life cycle of assets only.

To achieve more profitable supply chain operations, companies are moving towards integrated supply and demand planning. In a process-manufacturing environment it is not simply a case of setting up a production schedule in response to an accurate end-user "demand signal" but includes the demand set by plant assets for Maintenance, Repair and Operating (MRO) materials. There is a definite interdependency between EAM and SCM. To integrate the two is not only desirable, but also essential. The market has stopped thinking of the supply chain as a simplified series of events. It's a highly complex network of related supply chains required to manufacture a finished product. DNA Enterprise Asset Management (DNA EAM), a company that is part of DNA Supply Chain Investments Limited (DNA SC), came to realise this in its drive to optimise assets. It investigated the MRO supply chain and found the traditional supply chain to be unsuitable for MRO materials. DNA EAM found a second supply chain within the "Make" function of the traditional (production) supply chain. It is a supply chain that is initiated when a plant is in operation and is in the service and support of assets. The integrated Enterprise Asset Management Supply Chain (EAM SC) model consists of an Operate, Buy, Move, Store and Maintain function. DNA EAM calls the integrated asset management supply chain the Indirect supply chain and the production supply chain the Direct supply chain.

The Maintenance and Repair (M&R) demand signal is the integrator between asset management and the supply chain. There are several ways that the demand signal can be enhanced. Most noticeably it is

enhanced by changing from corrective to preventive maintenance, using scientific optimisation techniques such as Reliability Centred Maintenance (RCM), and the correct selection and implementation of EAM software.

DNA EAM has commercialised the indirect supply chain. The value proposition is based on greater profitability due to increased production revenue and savings on operational expenses, and reduced life cycle costs of assets through decreased M&R inventories and asset support costs. The power of the indirect supply chain lies not with the value proposition or commercialisation of it, but the understanding, clarity, and unification of the two disciplines.

SAMEVATTING

Hierdie studie is 'n uitvloeisel van die outeur se praktiese ervaring tydens sy pionierswerk, in die integrasie van batebestuur en die aanvoerketting. Dit het gebeur in 1999 – 2000 tydens 'n projek waar die outeur aangestel is as projekbestuurder. In dié tyd het hy 'n begrip ontwikkel vir die interafhanklikheid tussen die twee dissiplines. Dit vorm die tema van hierdie tesis.

'n Aanvoerketting is verantwoordelik vir die verskaffing van materiaal, wanneer daar 'n behoefte is vir 'n vervaardigde produk. Die tradisionele aanvoerketting bestaan uit vyf funksies naamlik: Koop, Vervoer, Stoor, Vervaardig, en Verkoop. Die tradisionele aanvoerketting is ideaal geskik vir die vervaardigings omgewing. Aanvoerkettings vereis effektiewe bestuur en optimaliseering. Die dissipline wat daarna omsien staan bekend as aanvoerkettingbestuur. Die doel van aanvoerkettingbestuur is om seker te maak dat vraag en aanbod gehandhaaf word. Aanvoerkettingbestuur is geweldig belangrik vir maatskappye wat kompetierend en winsgewend wil wees. Om die rede, plaas produksie bestuurders klem daarop en is dit huidiglik die nommer een strategiese prioriteit in die vervaardiging omgewing.

Batebestuur is verantwoordelik vir die verbetering van die opbrengs van 'n belegging, of die opbrengs van kapitaalgoedere deur middel van die doeltreffende bestuur van bates. Maatskappye kry selde die geleentheid om batebestuur toe te pas in die beplannings, aankoop, installering en die wegdoen stadiums van 'n bate. As gevolg hiervan word batebestuur geassosieer met bate instandhouding.

Maatskappye is besig om vraag en aanbod te integreer weens die druk om meer winsgewend te wees. In 'n vervaardigings omgewing is dit nie bloot 'n geval van 'n produksie skedule op te stel gebaseer op die aanvraag van verbruikers nie, maar sluit die aanvraag in, instandhouding, herstel, en bedryfs materiaal vir bates. As gevolg hiervan, bestaan daar 'n mede-afhanklikheid tussen bate en aanvoerkettingbestuur. Om die dissiplines te integreer is nie alleen wenslik nie, maar noodsaaklik. Die bedryf het onlangs sy sienswyse van aanvoerkettings verander. Voorheen is 'n aanvoerketting beskou as 'n eenvoudige reeks gebeure nodig om materiaal te verskaf vir 'n produksie proses. In werklikheid bestaan dit uit komplekse interafhanklike aanvoerkettings wat almal benodig word om 'n produk te vervaardig. DNA Enterprise Asset Management (DNA EAM), 'n maatskappy binne DNA Supply Chain Investments Limited (DNA SC), het hierdie verskynsel geïdentifiseer tydens bate optimaliserings projekte. Verdere ondersoek het gewys dat die tradisionele aanvoerketting nie geskik is om instandhouding, herstel, en bedryfs materiaal te bestuur nie. DNA EAM het 'n tweede aanvoerketting gevind binne die "Vervaardigings" stap van die tradisionele aanvoerketting. Hierdie aanvoerketting kom in aanvang wanneer 'n vervaardigings proses begin en masjinerie in bedryf gestel word. Hierdie aanvoerketting bedien en ondersteun bates. Die nuwe geïntegreerde batebestuur aanvoerketting bestaan uit die vyf funksies van: Bedryf, Koop, Vervoer, Stoor, en Instandhouding. DNA EAM tref onderskeid tussen dié twee aanvoerkettings. Die rou materiaal

aanvoerketting staan bekend as die Direkte aanvoerketting en die instandhouding, herstel, en bedryfs materiaal aanvoerketting as die Indirekte aanvoerketting.

Die aanvraag (sein) vir instandhouding, herstel, en bedryfs materiaal is die integreerder van batebestuur en die aanvoeringketting. Daar is verskeie maniere om die instandhouding, herstel, en bedryfs materiaal aanvraag sein te verbeter. Die grootste bydrae word gemaak wanneer 'n maatskappy verander van korrektiewe na voorkomende instandhouding en instandhoudings optimaliserings tegnieke gebruik word, soos betroubaarsheids gesentreerde instandhouding.

DNA EAM het dit reg gekry om die indirekte aanvoerketting te kommersialiseer. Die kommersiële waarde is gebaseer op die verhoging van 'n maatskappy se wins weens verhoogte produksie syfers, 'n afname in bedryfs onkoste en die afname in bate onderhouds kostes. Die werklike waarde van die geïntegreerde model, is geleë in die feit dat dit 'n nuwe uitkyk gee op 'n besigheid en die dissiplines van bate en aanvoerkettingbestuur verenig.

ABBREVIATIONS

ABBREVIATIONS	
3PL	3rd Party Logistics Operators
4PL	4th Party Logistics Operators
ACSP	Annual Customer Support Plan
APS	Advanced Planning Systems
BOM	Bill Of Materials
BPE	Business Process Engineering
CAPEX	Capital Expenditure
CBM	Condition Based Maintenance
CMMS	Computerised Maintenance Management System
CM	Corrective Maintenance
CRM	Customer Relationship Management
CRP	Continuous Replenishment Planning
DB	Database
DC	Distribution Centre
DNA EAM	DNA Enterprise Asset Management
DNA SC	DNA Enterprise Supply Chains
EAM	Enterprise Asset Management
EAM SC	Enterprise Asset Management Supply Chain
ECR	Efficient Consumers Response
EDI	Electronic Data Integration
EM	Emergency Maintenance
EOI	Economic Order Interval (EOI)
EOQ	Economic Order Quantities
EPS	Earnings Per Share
ERP	Enterprise Resource Planning
FMECA	Failure Mode Effect & Criticality Analysis
GL	General Ledger
HBS	Hardware Breakdown Structure
HR	Human Resources
IM	Inventory Management
IT	Information Technology
JIT	Just In Time
KPA	Key Performance Areas

ABBREVIATIONS	
KPI	Key Performance Indicators
LAN	Local Area Network
LCC	Life Cycle Cost
LLP	Lead Logistics Provider
LTA	Lost Time Available
LTL	Less Than Load
M&R	Maintenance & Repair
MRO	Maintenance, Repair and Operating
MRP I	Material Requirement Planning
MRP II	Manufacturing Resource Planning
MSA	Maintenance Significant Assets
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NDT	Non Destructive Testing
OEM	Original Equipment Manufacturers
OHSA	Occupational Health & Safety Act
PM	Preventive Maintenance
PMTS	Preventive Maintenance Task Selection
PO	Purchase Order
PPE	Plant Property & Equipment
PR	Purchase Requisition
R	Reliability
RCM	Reliability Centred Maintenance
RFQ	Request For Quotation
ROA	Return On Assets
ROI	Return On Investment
R&D	Research & Development
SC	Supply Chain
SCM	Supply Chain Management
SCP	Synchronised and Collaborative Planning
SKU	Stock Keeping Unit
SLA	Service Level Agreement
SMD	Standard Modifier Dictionary
SQL	Structure Query Language
SMB	Small and Medium Businesses

ABBREVIATIONS	
SS	Safety Stock
SSI	Shared Services Infrastructure
SSP	Single Service Provider
TCO	Total Cost of Ownership
VMI	Vendor Managed Inventory
WAN	Wide Area Network
WBS	Work Breakdown Structure
WIP	Work In Progress
WTS	Windows Terminal Server
Y2K	Year 2000

TERMINOLOGY AND DEFINITIONS

1. **3rd Party Logistics (3PL) Service Provider:-** A 3PL provides a service of combined, specific activities along a supply chain.
2. **4th Party Logistics (4PL) Service Providers:-** A 4PL is a supply chain integrator that assembles the resources, capabilities, and technology of its organisation with those of other organisations to create a comprehensive integrated supply chain service capable of assessing, designing, building and running innovative supply chain solutions.
3. **Assets:-** Assets are understood to be anything that is tangible, has capital value, can be repaired, and is sequenced or scheduled with other assets in such a way as to be able to create a product or provide a service.
4. **Availability:-** The ability of an asset (under combined aspects of its reliability, maintainability and maintenance support) to perform its required function at a stated instant of time or over a stated period of time.
5. **Best of Breed:-** A "best of breed application" is one in which specialized applications from multiple suppliers are involved. A "best of breed solution" is made up of multiple suppliers working together. If the client becomes dissatisfied with any single component, that component can be replaced with another compatible product. The remaining components stay in place.
6. **Cataloguing:-** Cataloguing is a best practice methodology that incorporates engineering expertise with superior materials and inventory management principles in managing descriptions of spare parts. With cataloguing, inventory items are uniformly described to pre-determined templates and bar coded. This provides a common language allowing better communication between the maintenance end-users, inventory controllers and suppliers alike, providing easy access to correct item specifications. The data structure allows users to search, purchase and maintain parts in a consistent manner either by descriptions or supplier part or drawing numbers.
7. **Computerised Maintenance Management System (CMMS):-** A CMMS is a computer based management application that assists a user in tracking and managing maintenance work.
8. **Condition Based Maintenance (CBM):-** Condition based maintenance is repair maintenance performed on assets based on observations of condition as provided by Non Destructive Testing (NDT), trending and objective analysis.
9. **Consignment Stock:-** Consignment stock places the responsibility to manage a selected range of inventory items, on site, on behalf of stores on an approved materials supplier.
10. **Corrective Maintenance (CM):-** Corrective maintenance is the performance of unplanned (i.e. unexpected) maintenance tasks to restore the functional capabilities of failed or malfunctioning assets that have no safety or production impact. Corrective maintenance has no immediate priority.
11. **Emergency Maintenance (EM):-** Emergency maintenance is the immediate performance of unplanned (i.e. unexpected) maintenance tasks to restore the functional capabilities of failed assets that resulted in a production loss or unsafe conditions.

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12. **Enterprise:-** The term enterprise is used to describe organisations that have capital-intensive assets and utilise them to earn revenue.
 13. **Enterprise Asset Management (EAM):-** The official definition of Enterprise Asset Management - EAM is the discipline of improving the Return Of Investment (ROI) and Return On Assets (ROA) of capital-intensive assets through their effective and efficient management.
 14. **Enterprise Asset Management (EAM):-** In lay terms, the purpose of Enterprise Asset Management (EAM) is to maintain, or increase, asset value through its many lifecycle phases.
 15. **Failure:-** The termination (full or partial) of the ability of an item to perform a required function.
 16. **Hardware Breakdown Structure(HBS):-** A HBS is a structured inventory of plant assets.
 17. **Holding Costs:-** Holding cost is the cost associated with holding one unit of an item in stock for one period of time, incorporating elements to cover capital costs for stock, taxes, insurance, storage handling, administration, shrinkage, obsolescence and deterioration.
 18. **Inbound Supply Chain:-** The inbound supply chain buys, moves and stores raw materials required for production.
 19. **Inventory Fill Rates:-** Is an item based measurement that shows the percentage of demands that were met at the time they were placed. Fill rate only measures what happens when demand occurs.
 20. **Inventory Service Levels:-** Inventory service levels are understood to be the desired probability that a demand can be met from stock.
 21. **Just In Time (JIT):-** JIT is a dependent inventory control philosophy, which views asset management as a system in which all operations, including the delivery of M&R materials needed for maintenance, occur just at the time they are needed.
 22. **Lead Time:-** The total time between the decision to place a replenishment order of an item until it is available for use. That is, the sum of order lead time, purchasing lead time, transit time and any item inward lead time for that replenishment order.
 23. **Location:-** A location is a fixed physical place on a plant performing a process or a function. Locations have the need for comprehensive maintenance records regarding all types of maintenance.
 24. **Logistics:-** Logistics is the movement of goods, supplies, equipment or people by road, water, air, rail, shipping, or pipeline.
 25. **Maintenance:-** Maintenance is a combination of all technical and associated administrative actions with the intent to retain an asset in, or restore it to, a state in which it can perform its required function.
 26. **MRO Materials:-** MRO materials are materials that are consumed by a company rather than forming part of its output.
 27. **Outbound Supply Chain:-** The outbound supply chain moves, stores and sells the final product to the customer and end-user.
 28. **Outsourcing:-** Outsourcing is understood to be an outside company's provision of the products or services associated with a major function or activity of a user organisation.
 29. **Planned or Proactive Maintenance:-** Planned maintenance is maintenance organised and carried out with forethought, control and the use of records to a predetermined plan. Planned maintenance

is also known as proactive maintenance since maintenance is based on the condition of an asset and usually takes place before the asset fails.

30. **Preventive Maintenance (PM):-** Preventive maintenance is the repeated performance of inspections and or servicing tasks that have been pre-planned (i.e. scheduled frequency, resources, materials, tools) for accomplishment at specific points in time to retain the functional capabilities of assets.
31. **Raw Materials:-** Raw materials are materials that are used in a manufacturing process to form a final product rather than being consumed by the company itself.
32. **Reliability:-** Reliability can be defined as the probability that a system or product will perform in a satisfactory manner for a given time when under specified operating conditions.
33. **Reliability Centred Maintenance (RCM):-** RCM is a process used to determine the maintenance requirements of any asset in its operating location.
34. **Shortage Cost:-** A shortage cost is defined as the economic consequence of an external or internal inability to meet a demand for MRO and raw materials from stock.
35. **Single Service Providers (SSP):-** Single Service Providers (SSP) are independent operators who are contracted by companies requiring specific supply chain services.
36. **Sourcing and Procurement:-** Sourcing and procurement is a process of obtaining goods, services or facilities from suppliers in the correct quality and quantity.
37. **Stock Carrying Costs:-** Stock carrying cost is the total cost associated with holding stock. The cost consists of the unit purchase cost, the reorder cost, the holding cost and stock out or shortage cost.
38. **Supply Chain (SC):-** The official definition of a Supply Chain - SC is a network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer. In a broad sense a supply chain consists of two or more legally separated organisations, being linked by materials, information and financial flows.
39. **Supply Chain (SC):-** The layman's definition of a Supply Chain - SC is the movement of materials in response to the demand of a product.
40. **Supply Chain Management (SCM):-** The official definition of Supply Chain Management - SCM is the task of integrating organisational units along a supply chain and coordinating materials, information and financial flows in order to fulfil customer demands with the aim of improving competitiveness of a supply chain as a whole.
41. **Supply Chain Management (SCM):-** The layman's definition of Supply Chain Management - SCM is all about supply meeting demand.
42. **Unplanned or Reactive Maintenance:-** Unplanned or reactive maintenance is maintenance carried out to no predetermined plan as a result of an asset that has failed.

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This study is dedicated to my Father and Mother.

Dad - I finally did it - please accept this as small token of my appreciation and love for you. May your spirit find peace in Heaven.

Mom - thank you for the love, support and belief in me. Your faith in me has carried the day. May Christmas 2002 be a memorable one.

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