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A Cost Benefit Analysis of an Automotive Industry Solution to Intercontinental Supply Chain Operations

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Abstract:

This paper describes a cost benefit analysis (CBA) of the Materials Off-Shore Sourcing (MOSS) project. The project focused on improving the operation of US inbound intercontinental supply chains of automotive parts. The MOSS project sought to reduce transit time, transit-time variability and inventory by providing a collaborative environment engaging original equipment manufacturers (OEM), suppliers, ocean carriers, logistics service providers, freight forwarders, and customs brokers. MOSS developed an innovative approach to resolving the significant problems of visibility, data quality, and customs compliance. The benefit analysis explains how MOSS contributes to reduce transit-times and transit time variability, and what benefits could be derived from it. The costs analysis considers one-time investments as well as recurring costs of deploying MOSS conforming software as 'Software as a Service'. The results of the CBA indicate an economically feasible investment with a payback period of 3 months and give support for managers' preparation of a possible investment decision. Difficulties for MOSS deployment are discussed, with emphasis on collaboration problems within a supply chain.

1. Introduction and Problem Statement

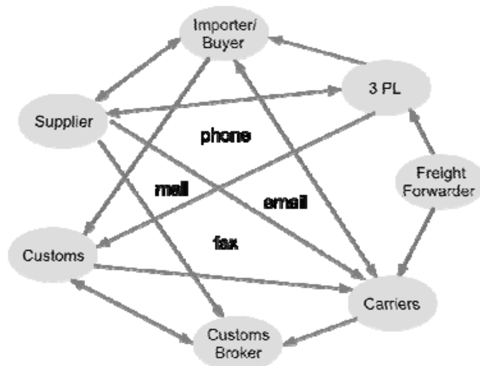
During the transportation of goods in intercontinental supply chains, managers cope with a serious lack of visibility, expensive and error-prone communications, as well as uncertainties of transport time and variability. Coyle et al. show that in the US economy, transportation costs amounted to 60 % of all logistics cost in 2007 [9] – partly because of these problems. This paper describes a cost benefit analysis (CBA) of a solution to improve operations of intercontinental automotive supply chains. The Materials Off-Shore Sourcing (MOSS) project put the solution forward, initiated by the Automotive Industry Action Group (AIAG) in 2005.

1.1. Business-to-business communication

Prior to project initiation, AMR Research Inc. conducted a survey of AIAG member companies to understand the current obstacles and processes of intercontinental transportation [4]. The survey revealed, among other things, that visibility is very limited during overseas transportation. Information about the shipment status, rarely available in a timely manner, remains mostly hidden in diverse proprietary systems. Only 20 % of respondents know when the cargo departs the foreign port, for example. Further, MOSS studies discovered that the lack of communication and documentation were one of the main reasons for delays and disruptions in intercontinental shipments. (AIAG, 2009)

The analysis of the communication processes in intercontinental supply chains also showed that processes execute as isolated point-to-point exchanges between business partners, primary by use of phone, fax, email, and paper (see as Illustration 1).

Illustration 1 Point-to-point communication in typical intercontinental supply chains without MOSS



These types of communication caused the greatest problems for 90 % of respondents who move data through a long-distance supply chain [8]. Less than 10 % claimed electronic exchanges of data; e.g., Electronic Data Interchange (EDI). Overall, 80 % of all data was re-keyed at least once and 50 % of data multiple times [4].

Many documents are produced in the ocean transport of goods, traditionally created and processed in paper form and then re-keyed into the proprietary system. This adds time, cost and errors to the process. 40 % of respondents cited documentation-related reasons for delays or disruptions in intercontinental shipments [2].

1.2. Business-to-government communication

Stakeholders are incurring unnecessary and high costs in their effort to comply with customs and other government agency requirements. For example, importers are required to file the Importer Security Filing (ISF) 24 hours prior to loading the container onto a vessel [27]. Since required data must be collected across the supply chain participants and their proprietary systems, the cost for implementing the ISF is high. The US National Association of Manufacturers (NAM) estimates in excess of $20 billion per year to fulfill the ISF requirements. Furthermore, they cite “that the proposed rule will create an estimated delay of two to five days before cargo can leave the foreign port of export” [19] We believe that these estimates are a bit exaggerated; nonetheless, it is likely that all governments will establish new compliance and targeting systems that will demand higher quality data. Failure to provide that data will result in additional delays, compliance problems, increased inspections, and monetary penalties [2].

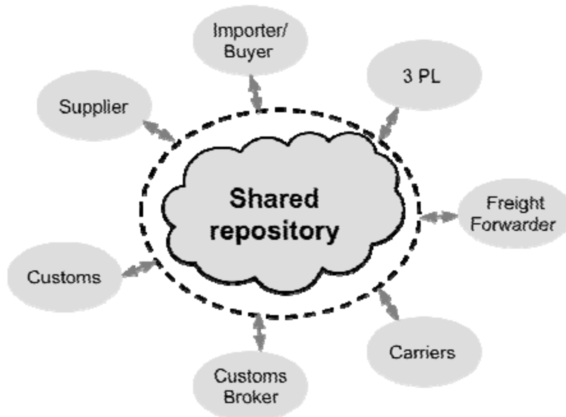
1.3. Other challenges

There are other challenges concerning strategic supply chain management and flexibility. Quick responses to supply chain design changes (including change of locations, service providers, or suppliers) are crucial to keep competitiveness. With a change of a service provider, problems may emerge with differing procedures and information technology solutions, and the cost for switching can diminish the advantage [10].

2. Problem resolution with MOSS recommendation and pilot

MOSS project participants concluded that many of the problems described above could be resolved if stakeholders were to conduct their business processes and communications using a shared repository to collect all necessary information. Timely information would be available to all participants as it is produced. Users would include OEMs, suppliers, carriers, logistics service providers, freight forwarders, and customs brokers, as shown in Illustration 2. One's access is based upon his role and business rules [2].

Illustration 2 MOSS-Shared repository of information with real-time access by all participants



Processes coordinated with the MOSS solution include, at least, master purchase order specification, communication of order forecast, purchase order placement, transportation booking, and US customs clearance [10].

A shared repository will improve the stated problems of visibility, data quality, compliance and documentation. However, the idea of a shard repository across numerous participants cannot be implemented efficiently with conventional software and ordinary client-server technology. Up-front investments, maintenance and up-dates would be costly and flexibility in the supply chain design could mostly be realized with unjustifiable costs.

The economically feasible MOSS solution is designed to be deployed as Software as a Service (SaaS), which avoids point-to-point communication. SaaS provides access to the software through the web without installation on users' systems. Configuration of the software can be done in real-time web conferencing with the users, which is an essential enabling approach to cost-effective deployment [2, 10]

There are two important capabilities of the new solution. First, it enables tracing of each unit of information through its entire "life cycle". This reuse capability increases data quality dramatically since it avoids error-prone re-keying processes and redundancy. Secondly, it provides complete visibility into the flow of information, the execution of business processes, and shipment status. Neither of these capabilities is possible with a point-to-point communication between two partners.

Interested readers are referred to a detailed description about the specification of the message types to the NIST MOSS Project Worksite [17]; and Denno and Comerford give insight into further information about the roles und their task within the MOSS model [3]. Similar commercial ideas are on the market – for an example see [11].

As part of the MOSS team, a software vendor developed MOSS-confirming SaaS solution, called Trade Collaboration System (TCS). The TCS was used in a pilot demonstration, which managed shipments of service part batteries in a Korean-U.S. automotive supply chain. The supply chain executes 1 379 ocean shipments per year with an annual purchase volume of $55 million. The remainder of this paper focuses on an economic analysis of the MOSS approach and often refers to this pilot [2].

3. Benefits Analysis

The benefit analysis explains how MOSS contributes to reduce transit-times and transit time variability, and what additional benefits could be derived from them. First, we clarify our understanding of transit-time as the time during which the goods left the supplier and are received by the customer. Within the transit-time, goods are shipped between the overseas supplier and the US buyer's premises. The current MOSS solution eliminates wasted time until goods are released from US customs. Sipahi et al. [23] take also this view, but call it 'delay', covering besides the pure transportation time, additional time for information collection, decision making, and communication.

3.1. Direct benefits using MOSS solution

3.1.1 eDocuments

With MOSS, all necessary paper documents can be either attached as image paper documents to shipment information into the MOSS system or generated automatically as eDocuments (typically as pdf-format) by use of electronic information of the MOSS repository content. Image paper documents, such as certificate of origin or dangerous goods certificate, are provided externally by a government. Any participant, whose role in the supply chain allows it, can create system-generated documents on demand, in a pre-defined format, as soon as all needed information is available. Two such eDocuments were created for the pilot: e-invoice for cross-border movement and e-packing list, because missing or deficient invoices are the most cited cause of delays.

The following appraisal for savings on e-invoice and e-packing list is based on paper processing costs of $50 and $30, respectively. These estimates encompass the administrative costs of creating the document, and downstream handling such as re-keying, mailing, faxing, courier services, review and correction, and document retention [2]. With MOSS solution, the costs could be reduced by $30 per e-invoice and $20 per e-packing list, total savings accumulate to **$50 per shipment**.

It is hard to estimate the savings for e-documents, because information about the cost of paper invoices varies significantly – as low as $8 and as high as $70 [5 and 22, respectively; reasons 15]. Moreover, 30 % of respondents from the automotive sector of MOSS survey have costs between $20 and $50 and 12 % of more than $50. So, obviously the assumption of paper invoice cost is placed at the upper range. However, there is a common understanding, that switching to e-invoicing can save 60 % to 80 % of costs [2, 5, 7, 22].

3.1.2 Time and cost savings in process tasks

Taking processing of eDocuments as a given and coming back again to use the advantages of the shared information repository, MOSS is able to reduce both time and cost to process shipment documentation of a shipment and, therefore, increase process efficiency. MOSS participants had no intent to make substantial modifications to the business process flow at the current stage; nevertheless MOSS is able to eliminate all the processes that

- Create e-mails to forward information to other parties
- Provide information to an other party through other media than e-mail, by making phone calls and faxing
- Receive and process this type of information without any value added (open e-mail, reading, and placing its content in context in a workflow)

The following table shows how the supply chain participants were involved in creating information (marked as ■) and in processing the task with almost no value added (marked as X) in the pre-MOSS process.

Table 1 Involvement of supply chain partners in low value added activities in the pre-MOSS process

Activities	**Supplier**	**3 PL**	**Freight Forwarder**	**Ocean Carrier**	**US customs broker**	**Buyer**
Description of goods, etc.	■		X			
Ocean booking		X	■	X		
Documents preparation (Paper invoice, paper packing list, dangerous goods certificate, certificate of origin)	■	X	X	X	X	
Shipping instructions			■	X		
Drayage request	■	X	X	X		
Bill of Lading	X	X	X	■	X	
Advanced Shipping Notice	■	X	X			X
Arrival Notice		X		■	X	X

With MOSS, all the non-value added process tasks (marked with 'X') could be eliminated. The duration of 8 minutes per task and a $15 salary per hour is assumed to quantify the 21 avoided tasks (marked with 'X'). The result is a cost saving of **$42.00 per shipment.** These savings, however, do not show the primary effect to transit-time, because the waiting time between the parties involved are probably the key for significant reduction. That time is not estimated for this part.

3.1.3 Comply with US customs

The MOSS solution is designed to provide compliance with U.S. C-TPAT and WCO standards for secure trade. Since it makes all data and documents electronically accessible to a customs broker when needed, customs entry can be done electronically, upon pre-arrival basis. For that, delays at border entry points can be reduced and additional time can be saved with fast or immediate release after arrival at the port [25], without going in further detail.

Using the electronic clearance process with a MOSS also streamlines brokers' and customs' internal processes resulting in concomitant cost reduction. We anticipate similar savings in customs' broker fees to those experienced with the U.S. Customs and Border Protection (CBP) Free and Secure Trade (FAST) initiative on US-Canada and US-Mexico land crossings [26]. There, broker expenses were reduced by 50 % with complete electronic processing like a MOSS-process. Since customs' broker fees for the MOSS-pilot shipments are about $50 per entry, savings could be obtained of **$25 per shipment**.

The ISF (also known as 10+2), effective since January 2010, requires information for all foreign imports due to security reasons. It consists of 10 data elements, collected and composed from different supply chain parties. Recall that the NAM claimed 2-5 days delays before cargo can leave; MOSS solution provides all of the ISF data within seconds in a uniform format across deployments. It is obvious that time delays due to ISF requirements do not occur using MOSS conformed solution. Actual cost data from trading partners show that ISF compiling cost is reduced with MOSS from $25 to $2 per shipment, which result in savings of **$23 per shipment** [2].

The CBP FAST initiative resulted also in lower freight costs due to significant reductions in border wait times. Further monetary benefits will result from fewer delayed shipments, fewer customs inspections, fewer monetary penalties, and less storage and insurance fees, among other things [25]. Those benefits should be considered as MOSS benefits, but are not quantified in this paper.

3.1.4 Reduce firefighting activities

We conclude from the effects of streamlined and faster process combined with error-free communication and visibility that MOSS will reduce significantly the time and cost for humans to resolve communication problems due to data and transcription errors, unforeseen delays and consequential tasks - summarized as "firefighting activities. The MOSS-survey within the automotive industry revealed (1) 30 % of the respondents have added staff to handle problems, disruptions and/or issues related to government compliance over past 2 years, and (2) 15 % of shipments are delayed because of data deficiencies [2]. To estimate avoided costs, we conservatively assume that each problematical shipment involves at least 3 parties, each 10 min with a labor cost of $15 per hour. That adds to a total of $7.50 per delayed shipment considering variable labor cost only, which is probably far behind the reality. To distribute those costs over all shipments of the pilot trade lane (1 379 shipments either or not delayed), there is an average **savings of $2.25 per shipment.**

3.1.5 Qualitative effects of MOSS

The holistic view of the supply chain provided by MOSS presents a new opportunity to (1) capture, track, and report performance by individual trading partners, and (2) perform end-to-end analysis of the entire chain. Up-to-date status information about the location of the goods enables measurement of compliance performance and cost transparency for each of services rendered in their movement. That is put into practice by a milestone reporting tool, also based on MOSS, and performed in the pilot. Moreover, this tool can readily identify potential or actual problems, the culpable party, and possible contingency plans. Such real-time visibility indices enable quick and targeted remedial actions and interventions resulting in improved efficiency, higher arrival/delivery predictability, and stability in the transport process. It also improves the manager's ability to develop strategies in case of disruptions such as split shipments, alternate routings, and carrier changes. Finally, MOSS enables overall performance measurement and risk assessment for the entire supply chain. That does not speed up the execution of processes, and so it does not directly influence the transit time, but it is a precondition for time-saving activities and continuous improvement across the supply chain.

The design of supply chains, which includes partner selection and business process integration, is difficult. MOSS facilitates the implementation of strategic supply design decisions through its Software as a Service (SaaS) deployment. Such a deployment can enable reconfiguration of partners, locations, trade lanes, and transport modes quickly and with lower cost. Additionally, strategic and operational decisions can be fulfilled easily - for example, to switch to a more efficient partner who needs less transit-time or to relocate consolidation centers with lower costs.

Another challenge within the design of supply chains is to align incentives that induce participants to behave in ways that maximize supply chain performance. Among others, Narayanan and Raman highlight poor information distribution as one hurdle [20]. Partners with the better information improve their own performance and the performance of the entire chain as well. MOSS can decrease information differences with its visibility capabilities by tracking and monitoring more business variables, thereby making hidden actions visible [20].

Using MOSS, supply chain managers will have more confidence in the stability of the business processes, close more gaps for delays and transit-time variation, and enable continuous improvement. This, in turn, will cause a movement away from reactive "firefighting" towards a more pro-active response to unforeseen problems. As a result, managers will be able to reassess and improve sourcing strategies, order management, supplier management, transportation costs, price negotiations, and inventory levels.

3.1.6 Results of the direct benefits

Table 2 summarizes cost savings of a MOSS solution of about **$142 per shipment** identified above. For the sample trade lane the savings reach almost $200 000.

Table 2 Direct benefits with MOSS

MOSS-pilot	Savings per shipment	Savings-Pilot (1 379 shipments)
eDocuments	$ 50.00	$ 68 950
Time savings in process tasks	$ 42.00	$ 57 900
Comply with US customs	$ 48.00	$ 66 200
Reduce firefighting activities	$ 2.25	$ 3 100
Total	**≈ $142**	**≈ $196 000**

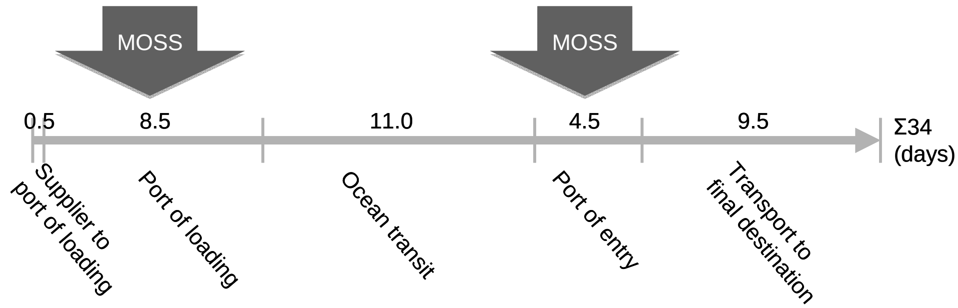
3.2. Benefits due to reduced transit-time and transit-time variability

Beyond the cost savings, in our context it is almost more important to evaluate the savings associated with reductions in transit-time and transit-time variability. As already outlined, MOSS has various impacts to this issue; however, in the following we try to determine details gleaned from the pilot experience.

3.2.1 Estimation of reduced transit-time

There was a 34-day transit-time for the MOSS pilot Korean-US trade lane. This time is between departure from the suppliers' premises and arrival of the goods in the buyers' warehouse. This is within the industry range as stated in the MOSS survey [2]. Illustration 3 pictures how much time was spent for the various actions on the way.

Illustration 3 Average transit-time in the MOSS pilot and MOSS' focus



Since MOSS sought to reduce wasted time during the transportation process, the highest impacts seem to be at the port of loading and at the port of entry. The goods do not move at those places; but, they literally wait until various providers carry out required export/import compliance and additional handling. Traditionally it is customary that carriers expect to receive the goods two to three days prior to their being loaded on the ship, and maybe more following the NAM statement. 24 hours before goods are loaded on the vessel, advance cargo information has to be submitted to the US CBP, including a vessel's cargo declaration and the ISF [2, 27]. The experienced waiting times in the pilot of 8.5 days at the port of loading and 4.5 days at the port of entry seem far too high. Unfortunately, the pilot demonstration ran parallel to the existing process; therefore, we can only assume the effect of MOSS on wasted time at the ports.

For the **port of loading** we assume that all the required documentation could be done within 2 days by using a MOSS conformed system, and take advantage of the benefits (e.g. ISF, and eDocuments) described above. However, it is commonplace that additional factors cause delays at the port, which cannot be solved with a MOSS implementation. Notteboom [21] gives capacity and infrastructure constraints as well as increased port congestion as some examples. The Korean port 'Busan' of the pilot lane is also affected by that [28], thus we take additional 2.5 days for such causes. Finally, we assume that a wasted **time reduction of 4 days** is very reasonable for the MOSS pilot, but probably in the upper range for other shipments.

For the **port of entry** the statistical mode of the broader set is 2 days [2], so the pilot also exceeds the average. Since pre-arrival customs clearance can come to an almost immediate release, we need only account for the time necessary to physically moving the goods to unload the vessel and to transfer to further end-haul facilities [25 and 26]. Thereby, we assume that a **time reduction of 1 day** at the port of entry is realistic.

Summarized, the total assumed **transit-time reduction is 5 days**.

3.2.2 Liquidity effect of a lower transit-time and transit-time variability

The most important consequence of transit-time reduction with MOSS is the possibility to reduce supply chain in-transit inventories. 2007 US economy indicated that organizations face inventory carrying costs of 34 % on average of total logistics cost. [9]. Besides inventory other effects are explained shortly.

First, there is a one-time liquidity effect, since a 5 days inventory value is taken out of the chain. Avoiding those 5 days and with them ocean transportation expenditures ($1 400 per shipment) and customs (3 % of $55 million purchase value), there is a one-time liquidity effect of $800 000 for the MOSS pilot (1.46 % of purchase volume). This assumed decrease of 5 days may not be effective for all imports or trade lanes. Therefore, we calculate a one-day decrease, which amounts to $160 000 (0.29 % of purchase volume) ceteris paribus.

A second one-time liquidity effect is the reduction of buffer inventory by reducing the safety-stock level or reorder point. This effect depends on the decrease of transit-time variation. Since during the pilot, all cargo needed the same time and previous data is not available, the effect of MOSS on transit-time variability and inventory reduction could not be estimated directly. Survey respondents pointed out that supplier, U.S. customs, and customs in export country as top 3 reasons for lead-time variability; and the meridian of respondents had a transit-time variability of 10 days [2]. Replying to the survey, MOSS has a positive impact at least to the supplier and the US customs, as outlined above. Together with the other benefits of information sharing, MOSS is able to reduce uncertainties as one of the many reasons for transit-time variability. Heydari et al. [13] examine the effect of increased lead time (comparable with transit-time) variability, and demonstrated effects like inventory fluctuations, and increased order variances. Since the buffer stock in the pilot lasts for 90 days, we assume that an impact of transit-time reduction could reduce the buffer levels by at least 7 days. The MOSS survey justifies the 7 day assumption, as it reveals that respondents keep 16-25 days (meridian) of buffer stock to cover ocean shipment delays [2]. One day buffer stock reduction could improve liquidity approximately by $150 000 (based on purchase volume of $55 million), thus a 7 days reduction is commensurate with $1 050 000.

3.2.3 Savings caused by reduced inventory

The most important impact of transit-time reductions can be quantified with on-going reductions of inventory carrying costs and inventory values, assumed in the one-time liquidity effect. Coyle et al. [9] define inventory carrying cost as capital cost, storage space cost, inventory risk cost (like obsolescence risks, damage, pilferage) and inventory service cost (like insurance and taxes). Capital cost applies to both, in-transit and buffer inventory, whereas the other cost, in here summarized, as inventory maintenance costs are relevant for buffer stock only. We used 6 % for capital cost and 8 % inventory maintenance cost, covering administrative expenditures and handling costs as well. Those percentages were experienced in the MOSS team [2], and literature shows 25 % and 24 % [18, 9, respectively].

Using these assumptions for inventory carrying costs to quantify the savings of the MOSS-pilot, with reductions of 5 days in-transit stock ($800 000) and 7 days buffer stock ($1 050 000), there are on-going savings of **$195 000 for the MOSS-pilot** (approximately 0.35 % of purchase volume). Considering the **1 day reduction scenario** for both, in-transit ($160 000) and buffer stock ($150 000), there are on-going savings incurred of approximately **$30 000** (0.06 % of purchase volume)
Table 3 summarizes the performed calculation.

Table 3 On-going savings resulted of a reduction in transit-time and transit-time variability

	Type of inventory reduction	Value of inventory	Savings (6 % capital cost; 8 % maintenance for buffer)	Percentage of import value
MOSS-Pilot	In-Transit [5 days]	$ 800 000	$195 000	0.35 %
	Buffer [7 days]	$1 050 000		
MOSS – 1 day scenario	In-Transit [1 day]	$ 160 000	$ 30 000	0.06 %
	Buffer [1 day]	$ 150 000		

4. Costs Analysis

4.1. Initial investment

As mentioned above, MOSS solution was deployed as SaaS. The initial investment, calculated in this section, refers to the cost of setting up the business relationship between a buyer and a seller. They are also the costs of performing supply chain analysis, configuration, and training. Supply chain stakeholders and the software provider(s) collaborate to perform these activities. With its "business process-orientation", the configuration task typically would not require advanced information technology skills, but only operational knowledge of the supply chain. The **initial investment** for the particular software used in the MOSS pilot was **$32 000** per deployment [2].

4.2. Recurring costs

The recurring costs, realized as subscription pricing and SaaS deployment, are expenditures for providing trading partner connectivity, user access and support and, transaction handling [2], see Table 4.

Table 4 Recurring costs per month/ year per buyer/ seller relationship in MOSS-Pilot

Activity	Cost per task (per month)	Quantity Required	Activity Total (per month)	Activity Total (per year)
Trading Partner connectivity	$500	6 [trading partners]	$3 000	$36 000
User Access and Support	$100	20 [user]	$2 000	$24 000
Transaction handling	$ 25	1 379 [shipments (pilot)]	$2 873	$34 475
Total recurring costs per year				**≈ $95 000**

Since the on-going cost of SaaS is proportional to the level of usage, predictable subscription pricing causes variable expenditures, which simplifies budgeting, forecasting and cost calculations. The result is a highly flexible solution with low up-front investment, easy configuration, and minimal maintenance [1, 10]. Additionally, it can be implemented incrementally, one trade lane at a time. This implies that investment can be distributed over time and future deployments can benefit from lessons learned. More detailed discussions, such as who does host the system and which party does pay which contribution, are beyond this papers' scope.

5. Results of the costs benefit analysis and critical discussion

5.1. Financial Results

The result of the CBA shows an economically feasible solution considering quantified benefits, initial investment and recurring costs. It is based on the 1 day reduction scenario. Note, one-time liquidity effect is not relevant to this analysis. The commonly used indicators including net present value (NVP), internal rate of return (IRR), and payback period are presented to justify an investment decision.

Net present value (NPV) is defined as the present value of one or more future net cash flows, less any initial investment costs [12]. The cash flow for the pilot is composed of $126 000 on-going benefits ($196 000 savings due to improved process efficiency and $30 000 for saved inventory carrying cost), and $95 000 for recurring cost, see Table 5.

Table 5 Cash flow for the MOSS pilot in a 3 year period

	Year			
	0	1	2	3
Initial Investment	-$32 000	0	0	0
On-going benefits (compare Table 2and Table 3)		+$226 000	+$226 000	+$226 000
Recurring costs (compare Table 4)		-$ 95 000	-$ 95 000	-$ 95 000
Net Cash Flow		**+$131 000**	**+$131 000**	**+$131 000**

The 3 year period reflects the depreciation period for software products. A discount rate of 6 % (0.06), identical to the rate for cost of capital, is assumed to convert the anticipated net cash flows to their present market values [6]. For a 3-year period, the NPV is approximately $320 000 as shown below:

NPV = Initial Investment + (Net Cash Flow_1 x $(1+0.06)^{-1}$ + Net Cash Flow_2 x $(1+0.06)^{-2}$ + Net Cash Flow_3 x $(1+0.06)^{-3}$) ≈ $320 000.

The NPV is obviously positive and has a significant magnitude. Therefore, this investment would earn its 6 % cost of capital and additionally make a present-value contribution of $320 000. Considering that this value is based on 1-day reductions in buffer and in-transit inventory, this is a remarkable result.

The **Internal Rate of Return** (IRR) is defined as the interest rate at which the NPV is set to zero. In effect, it is the rate at which the sum of discounted cash flows is equal to the initial investment. Managers typically use the IRR for ranking investment alternatives.

NPV = 0 = Initial Investment - (Net Cash Flow1 x (1+IRR)-1 + Net Cash Flow2 x

(1+IRR)-2 + Net Cash Flow3 x (1+IRR)-3); IRR=4.06 (≈ 400 % interest)

Payback Period is defined as the period required recovering the initial investment. For some organizations this is a key metric.

Payback period = initial investment / net cash flows per year
= $32 000 / $(226 000-95 000) = 0.24 yrs ≈ 3 months.

The **payback period of 3 months** and an **IRR of 400 %** demonstrate that the investment of a MOSS deployment is economically reasonable.

5.2. Critical discussion

Since the benefits of MOSS seem to be overwhelming, which the financial results above seem to support, there is the question, why doesn't every company immediately start to deploy a MOSS solution. The precondition for a Moss deployment is that supply chain partners collaborate and are willing to apply the MOSS solution. Therefore, OEMs should not force suppliers and logistics service providers to implement MOSS without taking into account its relationship to them and their profitability concerns [16]. MOSS as an information technology just simply cannot replace personal relations, mutual understanding as well as a professional supplier and customer relationship management [14]. The latter aspects are relevant keys to build trust between the supply chain partners, which is a precondition to accept that the best performance of the supply chain even though it might not be optimum for a single partner. [20]

On the one side, MOSS provides information to (1) master the transportation process collaboratively and efficiently and (2) make fast and effective decisions in case of unforeseen interruptions. Both are probably in everybody's interest. But on the other side, since MOSS gives insight into the progress of operation, it can provide data needed to analyze critical points and identify responsibilities for certain actions. If the relationship between the partners is not grounded on trust, not every partner will be willing to share this type of information about its business. That means that a crucial challenge of a MOSS deployment is to create win-win situations in order to give incentives for collaboration for every participant. Benefits, costs and risks must be distributed over the partners and they must be negotiated trustfully [24]. From that viewpoint MOSS is also able to give the information necessary to warrant trust, enable continuous improvement, and improve profitability [20].

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