Calculating the AIDC Return on Investment (ROI) within the Small to Medium Size Enterprise

Farhad Nabhani and Athanasios Klonis

School of Science and Technology, University of Teesside, Middlesbrough, TS1 3BA, UK
Email: f.nabhani@tees.ac.uk

Abstract

Automatic Identification and Data Collection (AIDC) technologies have been used extensively to reduce non-value adding activities across the supply chain. Radio Frequency Identification (RFID) is an AIDC technology that promises to revolutionize the global supply chain by enabling products to automatically identify their movement and location. Large organizations in the US and Europe have been piloting the technology, as the potential cost savings through this increased visibility are high. However, the required investment on the technology can be expensive and of high risk. This may be particularly true for Small Medium Enterprises (SMEs) with limited financial resource available for research and development. This paper presents a methodology for assessing the value and calculating the ROI of AIDC within SMEs based on process improvement and elimination of non-value adding activities. Although the applicability of the methodology was assessed within a UK manufacturing SME, it is anticipated that the results of this case study may be used by potential adopters wishing to assess the value of AIDC technologies in their operations.

Keywords: Automatic Identification Technologies, value adding activities, small medium enterprises, Return on investment.

1. Introduction

In modern global economy, large and small businesses need to work closely together while taking advantage of technology in order to create a more productive supply chain (DTI, 2004). Automatic identification technologies such as barcodes have been used extensively with management information systems to provide accurate and timely data and facilitate better decision making (Cohen, 1994; Palmer, 2001). Yao et al. (1999) argue that the ability to determine product status during the numerous logistic transactions within operations is crucial for company success. Tracking an object from the moment it arrives at the plant until it leaves as a finished product can dramatically reduce transaction time, offer real time visibility of stock, help make more accurate production plans and improve the efficiency of ERP systems (McFarlane et al., 2003).

Despite the obvious benefits of AIDC systems, many companies especially SMEs have yet to adopt such systems in their operations mainly because of their reluctance in investing in IT technologies. Radio Frequency Identification is a technology that has been available since the Second World War (Landt, 2005; Cardullo, 2005; Bhuptani and Moradpour, 2005; Kleist et al., 2004). Despite this fact, RFID has recently become the focus of supply chain improvement initiatives, since its potential uses in the supply chain have been realised (Angeles, 2005; Adams, 2005; Gilbert and Jabjiniak, 2004; Smith, 2005). RFID is an automatic identification and data collection technology quite different from traditional AIDC, as it does not require a line of sight and human intervention. The technology promises to create significant changes in modern business environments by providing the means to identify the location and movement of individual items in real-time, transforming supply chains into demand chains (Heinrich, 2005; Roberti, 2005; Allen, 2006) .

The adoption of a new technology can be lengthy, expensive and complex (Gunasekaran et al., 2006) and the implementation of RFID is no different. There are four different scenarios for RFID deployment; discrete process, intra-company, inter-company and synchronization (Fontanella, 2004). Calculations of costs and benefits resulting from possible usage of RFID may vary significantly depending on the application and the scale of the implementation (Byrnes, 2006), as for example manufacturers obliged to conform to an RFID mandate may assume the majority of costs such as tags and tagging labour, and they will benefit less from their investment in the technology than their supply chain partners (Poirier and McCollum, 2006). Although several authors have reported that an investment in RFID, as in any other investment, should justify itself through appropriate cost benefit analysis, there have been no reports on RFID ROI calculations for SMEs

To help organisations not familiar with RFID technology evaluate the benefits of the technology within their organisation, the Auto-ID centre has produced a Return-On-Investment calculator (RFID Journal, 2005). Albeit a significant step towards understanding potential benefits of the technology, the calculator has certain limitations which may be attributed to the development team of end-user sponsors of the centre (Auto-ID Center, 2006). Indicatively, the value of the tagged items may not exceed the threshold of £3,200 therefore the calculator cannot be applied in low-volume high-value organisations. In addition the calculator assumes an average £0.1 tag cost which is rather low for small sized orders or specialised tags.

The aim of this paper is to propose a universal methodology for assessing the value of AIDC systems in organisations based on process improvement and waste elimination. With the majority of current research focusing on retail and supply chain applications, it is anticipated that the results of this study will assist SMEs to assess the value of AIDC systems in their operations, quantifying the benefits and return on investment. The applicability of the methodology is also supported by a cost benefit analysis of RFID deployment within a low-volume, high-value manufacturing SME.

2. Methodology

The methodology presented in this paper is based on the fundamental concept of lean of eliminating waste. By definition, all activities that are not directly involved with the product are considered as waste or Non Value Adding (NVA). While it is appreciated that some of these activities are necessary for supporting the value adding activities in a process, any elimination or reduction in NVA activities can yield significant improvement.

The first step of the methodology involves the observation and understanding of the entire process. During this step the facilitator is required to observe and collect the necessary information about the process while developing an accurate description of the steps and factors that constitute and influence the process. The process mapping exercise may be conducted through a variety of methods which have been extensively described by Hines and Rich (1997). A combination of process flow analysis and process activity mapping is more appropriate for identifying and distinguishing the steps in value adding or not.

The second step of the methodology is to assess which steps may be eliminated or reduced through the application of AIDC systems. This step must take into account the people involved with the process and must question each step of the process in order to identify the areas where AIDC can create value. The completion of this step will result in the future, improved state of the process.

The third step of the methodology considers the implementation costs as well as the anticipated benefits of the future state. During this step all hardware, software and training costs for the future state are calculated and are contrasted to the anticipated benefits in respect to the initial process. Finally, the costs and benefits are used to calculate the ROI and create the momentum for moving forward with the implementation of AIDC. The methodology is illustrated schematically in Figure 1.

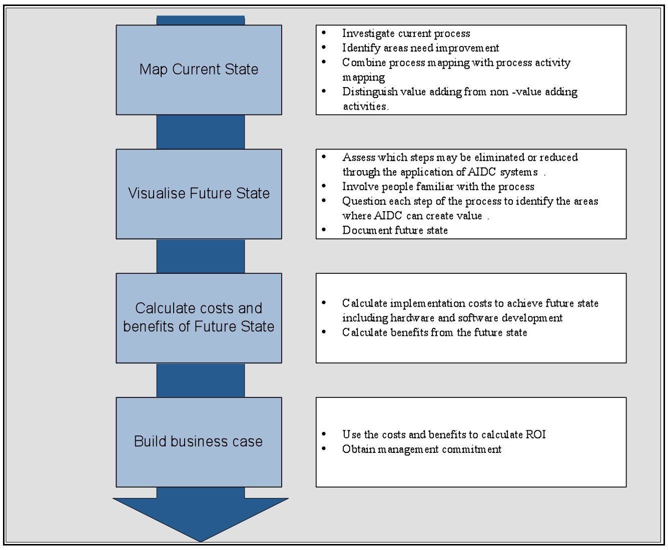


Figure 1. Steps in determining AIDC value

3. Application

The practical implications of the methodology are presented through the following case study, which involves a UK manufacturing SME specialising in the manufacturing and provision of engineering services for mechanical joint integrity. The company's headquarters, manufacturing facility and distribution of products are based in the North East of England, whilst the provision of engineering services is conducted from both the North East and Scotland.

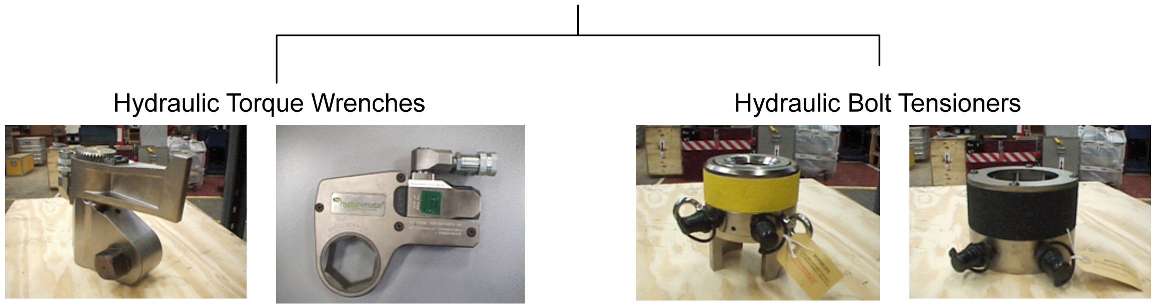
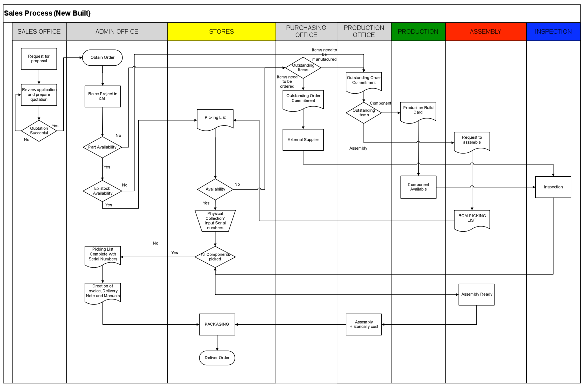


Figure 2. Company Products

The company has implemented an ERP solution to run both sides of its business, engineering services and manufacturing. The volume and the reactive nature of the transactions of hire assets during season of peak activity and the difficulty in reading serial numbers on current assets has contributed to an ineffective asset tracking system. The company has experienced problems with managing its moveable assets and has decided to implement an Automatic Identification and Data Collection system (AIDC) to have real time status and visibility of inventory. The methodology was applied in two discrete processes within the company, sales and provision of engineering services and all intermediate stages from obtaining an order to dispatching the product were examined.

STEP 1- Map Current State

The first step of the methodology examines how and why the processes are currently carried out, based on actual process observation rather than relying on previous process descriptions. Through direct observation, collecting live data from the shop floor and auditing the people involved in the process, a deep understanding of the environment and process was acquired. The completion of the process activity map resulted in a well-documented description of the process, whilst depicting the consisting steps, time required to complete each step and distinction of each step as operational, transportation, delay, storage and inspection. Figure 3, illustrates the steps constituting the current sales process and their allocation across the company's departments. Having verified the descriptive flowcharts for accuracy and completeness with the respective employees, the authors embarked to analyze the current state of each process to locate bottlenecks and wasteful activities that could be improved or eliminated through the use of an Automatic Identification System.



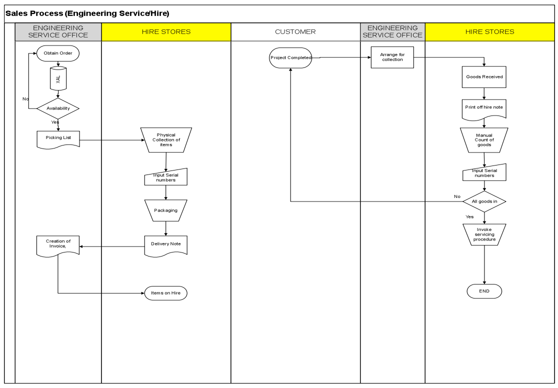


Figure 3. Cross-functional flowchart

The ERP system currently in place failed to work at its full potential due to the lack of real time data entry and errors due to the manual input of information. It was also evident that although manual inputs of data were critical for the information flow, were creating problems in the accuracy and availability of information in both sides of the business. They often were not performed on time resulting in errors which affected the operations across departments. For example, there were instances where employees working in the stores did not input the correct quantities or serial numbers as listed on the picking list, resulting in inaccurate stock levels. The errors in inventory visibility were further enhanced by delays in processing the documentation transferred around the plant in hard copies. For example, there were cases where an assembly was physically available at the stores, but it was not available on the system either because the production card had not been transferred to the production office to be historically cost or because it had not been properly filled in. This caused erroneous quotations and lost sales, fluctuations in demand and upset in production. The process was also overwhelmed with an unnecessary paper trail. Activities such as printing out picking lists and manual transfer to the relative departments were non value adding and took a substantial amount of time in the process.

Similarly, in the “Engineering Services process” manual data input was highlighted as a major waste in the process. Employees responsible for physically managing the tools in this process were also responsible for the creation of the dispatch documentation. There were cases where due to increased volume of orders increased workload and time pressure, a delivery note was not dispatched with the order. Instead, a copy of the picking list was dispatched while all paperwork was postponed creating a backlog. Significant errors were also observed in recording the correct serial numbers when the tools returned from the customer due to the off-hire condition of the tools.

STEP 2 - Visualising future state

In respect to the processes studied the minimum requirements which the future state should meet, were to increase process efficiency by eliminating manual data input and physical documentation transfer. The first task required the utilisation of an appropriate AIDC technology compatible with the company's existing ERP system and suitable for the characteristics of the company's assets. The majority of the assets were metallic, therefore any selected technology had to be applicable on the assets' metallic surfaces without compromising the equipments' integrity. Extensive investigation illustrated that the most appropriate technology for the application was a hybrid system of barcodes and RFID (Nabhani et al., 2005).

The second task obliged for the use of wireless enabled devices such as Portable Digital Assistants, capable of scanning barcodes and reading RFID tags. Since the ERP solution backend database was run using MSSQL 2000, wireless connection to the database was possible through Open Data Base Connectivity (ODBC) and ActiveX Data Objects (ADO).

These requirements were "translated" into project milestones and formed the basis for designing the future processes. After raising the Sales Order in the ERP system, the items listed on the order would be wirelessly transferred to the employee's Portable Digital Assistant (PDA), enabling the employee to prioritise and select a picking list through a selection of pending orders. During the picking process, all tagged items would be deleted from the picking list and the deletion of the last item from the list would invoke the creation of invoice and dispatch documentation. Similarly, in the event of any of the order items not being available, then this would be highlighted real time. A schematic of the proposed system is illustrated in Figure 4.

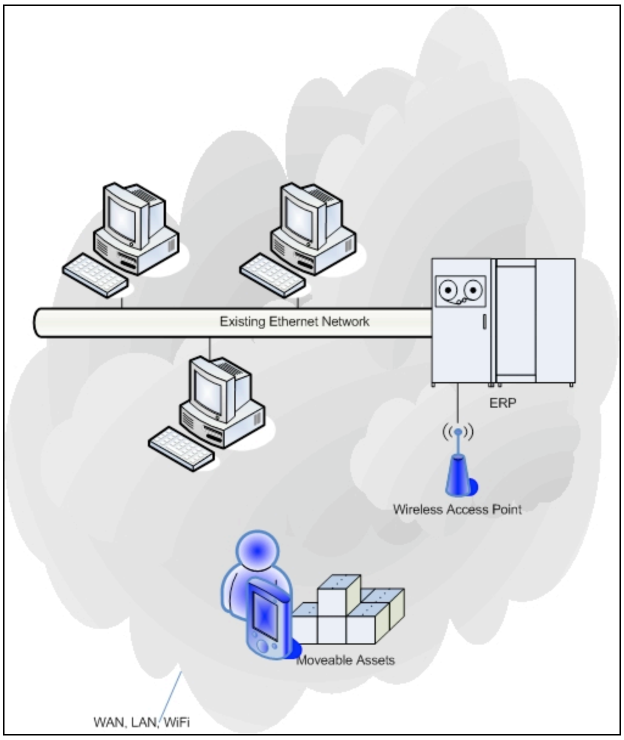


Figure 4. Future state schematic

Using process activity mapping, it was possible to distinguish between the value adding and non value adding activities in the process for a more detailed design and evaluation of a process (Slack et al., 1998). The flow and the activities' duration in the process were documented using this more analytical method of process mapping to identify the different types of activities and facilitate a comparison between the current state of the process and the proposed future state (Kolarik, 1995). The various steps in the existing process were documented by examining the activity as it took place.

Twenty-three steps were documented as the activities constituting the sales process. Three were identified as operational, seven transportation, one inspection, eleven delay and one as storage. The total time required for the completion of this process based on an average order of 5 tools was 2610 seconds, i.e. 43.5 minutes. The future process consisted of eight steps in total which were distinguished as three operational, two as delay, one as inspection, one as transportation and one as storage. Although the operational, inspection and storage steps in the process remained unaltered, there was a significant reduction in delay and transportation steps. With the utilization of AIDC, the process would be reduced to eight steps by the elimination of non-value adding activities. The duration of the future process could be reduced to 23 minutes.

The engineering services process map consisted of two processes, booking out and booking in. Although each process was examined separately, the process activity map considered both processes to illustrate the potential of improvement. The booking out process consisted of eleven steps and the booking in of seven. The total number of steps that were documented as the constituting activities in the hire process was eighteen; six were identified as operational, two as transportation, two as inspection, seven as delay and one as storage. The total time required for the completion of this process based on an average order of 5 tools was 1620 seconds, i.e. 35.5 minutes. The future process consisted of nine steps in total of which six were distinguished as operational, two as inspection and one as storage while the duration of the process could be reduced to 16 minutes. The current steps of the process are contrasted to the future steps in Figure 5.

SALES PROCESS (Current State)

Task Title	Task Description	Activity	Time (S)
1. Obtain Order	Raise Project in XAL and communicate purchase order	○	120
2. Check availability in XAL	Check all part codes are available.	□	60
3. Parts Not Available: Generate picking list hard copy	Create picking list quoting part-codes and quantities and pass to Purchase office	D	30
4. Outstanding order commitment	Invoke Purchase from external supplier or production of parts missing	D	30
5. Request to build	Create request to build list quoting part-codes and quantities	D	30
6. Forward request to build to Production Office	Forward request to build hard copy to production	⇨	60
7. Create production route card	Create production route card hard copy	D	30
8. Forward production card to production	Manual transfer of production route card	⇨	60
9. Record machining time	Manual record machining time on production route card	D	30
10. Return production card to production	Return competed production card to production	⇨	60
11. Manual input of part availability	Produced components are marked against system availability. Invoke assembly	D	300
12. Produced Items are taken to stores	Put items to designated locations	⇨	60
13. Transfer production card to assembly	Production card is tranfered to assembly area for the components serials to be recorded	⇨	60
14. Record serial numbers of parts going into assembly	Components serial numbers are recorded manually on production card	D	120
15. Return production card to production	Completed card is transferred to production office for the assembly to be historically cost	⇨	60
16. Assembly goes to stores	Physical assembly is moved to stores	▽	60
17. Assembly is historically cost	Recorded components numbers are logged against the assembly serial	D	300
18. Physical collection of items	Once the assembly is historically cost it is available for picking	○	300
19. Manual input of assembly serial numbers	Manually mark serial numbers against purchase order	D	120
20. Return Picking list to admin	Return completed picking list back to admin	⇨	60
21.Raise dispatch documentation	Create delivery note, certification and tools manual	D	300
22. Generate invoice	Create invoice	D	60
23. Pack and dispatch items	Equipment is put into cases along with respective documentation and is dispatched	○	300
Total		○ 3 ⇨ 7 □ 1 D 11 ▽ 1	**2610**

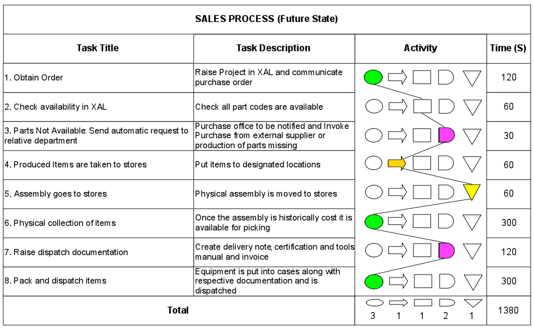
(a) Sales Process Activity Mapping

HIRE PROCESS (Current State)

Task Title	Task Description	Activity	Time (S)
1. Obtain Order	Raise project in XAL	○	120
2. Availability Check	Check availability in XAL and advise customer	□	60
3. Create Picking List	Create picking list quoting part-codes and quantities	D	30
4. Forward picking list to stores	Pass picking list to E/S stores	⇨	60
5. Collect items	Physical collection of items	○	300
6. Record item serial numbers	Manually record serial numbers on picking list hard copy	D	300
7. Packaging	Collect all items and place in dispatch cases	○	120
8. Create delivery note	Enter serial numbers in XAL and print delivery note	D	60
9. Pass delivery note copy to E/S office	Manual transfer of delivery note to E/S office	⇨	60
10. Generate invoice	Generate invoice and send to customer	D	60
11. Dispatch items	Dispatch items using company vehicle	○	60
Booking In			
12.(1) Arrange for collection	Receive notifcation about project completion and arrange for HPL carrier to collect goods	○	60
13.(2) Goods received	Place returned goods at return bay	○	60
14.(3) Print off hire note	Print off hire note to check for discrepancies	D	60
15.(4) Manual count of goods	Check all goods have been returned	□	360
16.(5) Record serial on off hire note	Manual record serial nembers	D	300
17.(6) Are all goods in?	Ensure all goods are returned and update database	D	120
18.(7) Move goods to service area	Invoke service procedure	▽	120
Total		○ 6 ⇨ 2 □ 2 D 7 ▽ 1	**1620**

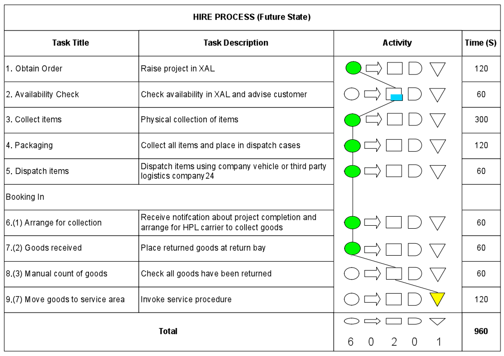
(b) Engineering Service Process Activity

Mapping



SALES PROCESS (Future State)			
Task Title	Task Description	Activity	Time (S)
1. Obtain Order	Raise Project in XAL and communicate purchase order		120
2. Check availability in XAL	Check all part codes are available		60
3. Parts Not Available Send automatic request to relative department	Purchase office to be notified and Invoke Purchase from external supplier or production of parts missing		30
4. Produced Items are taken to stores	Put items to designated locations		60
5. Assembly goes to stores	Physical assembly is moved to stores		60
6. Physical collection of items	Once the assembly is historically cost it is available for picking		300
7. Raise dispatch documentation	Create delivery note, certification and tools manual and invoice		120
8. Pack and dispatch items	Equipment is put into cases along with respective documentation and is dispatched		300
Total		3 1 1 2 1	1380

(c) Sales Process Activity Mapping (Future State)



HIRE PROCESS (Future State)			
Task Title	Task Description	Activity	Time (S)
1. Obtain Order	Raise project in XAL		120
2. Availability Check	Check availability in XAL and advise customer		60
3. Collect items	Physical collection of items		300
4. Packaging	Collect all items and place in dispatch cases		120
5. Dispatch items	Dispatch items using company vehicle or third party logistics company24		60
Booking In			
6.(1) Arrange for collection	Receive notifcation about project completion and arrange for HPL carrier to collect goods		60
7.(2) Goods received	Place returned goods at return bay		60
8.(3) Manual count of goods	Check all goods have been returned		60
9.(7) Move goods to service area	Invoke service procedure		120
Total		6 0 2 0 1	960

(d) Engineering Service Process Activity Mapping (Future State)

Figure 5. Current vs. Future state process activity mapping

To quantify the value of an investment in AIDC, cost and productivity data had to be incorporated into the process analysis. For the processes studied the data of Table I were obtained from the company and were used to calculate the benefits from reduction of inventory, stock taking time and efficiency improvement.

Table I. Company data

Annual sales (units)	931
Annual revenue	£4,387,449
Average tool sales price	£ 4,713
Inventory value (£)	£650,000
Carrying cost (%)	20%
Safety stock (%)	5 %
Times a physical count is performed	2
Time to complete a physical count	120 hours
Average number of SO handled per week by the process	30
Average labour cost (£/h))	14

In order to calculate the improvements in the process efficiency, the cost of the current process against the cost of the future process was calculated using equation (1).

(1) Annual Process Cost = Process duration (h) x Orders handled by process x hourly labour cost x 52

The current state of the sales process involved 23 steps over 43.5 minutes. The utilization of AIDC could reduce the process to six steps over 23 minutes, resulting in annual savings of £7,540. Similarly, the reduction of non-value adding activities in the engineering service process could result in a nine step process over 16 minutes and annual savings of £7,228, raising a total of £14,768 from efficiency improvement.

In most operations, a significant amount of money is tied up as safety stock. The use of an AIDC system can provide 99.9% accuracy and eliminate the need for safety stock (Pearce and Bushnell, 2000). The savings from the reduction in inventory are calculated from equation (2).

(2) Savings from safety stock = Carrying Cost% x Total Inventory Value x Safety Cost%

Additional benefits through the use of AIDC may be found in reducing time during inventory counts. It is reported that inventory count time may be reduced by 80% using AIDC (Pearce and Bushnell, 2000). The savings from reduced inventory count time may be calculated from equation (3).

(3) Times a physical count is performed x Time to complete physical count x Average cost labour hour x 80%

The physical count in the company took place over a period of 10 months (February to November). Each month 12 two-hour counts were performed hence the total physical count time was 240 hours. Reconciliation required an additional 240 hours, therefore a total of £5,376 could be saved.

3.4 Build Business Case

The final step of the methodology was to use the above metrics to present the value of an investment in the system. Although the future state had significantly less steps than the initial process, it was necessary to provide management with an acceptable ROI and payback period within 2 years, as designated by the company’s policy. The implementation costs for the system depend on the method employed and are distinguished in software and hardware costs (Nabhani and Klonis, 2007). The calculated savings are listed along the respective costs in Table II. For the purpose of the analysis the cost for implementing the most expensive technology (web service) is considered. The implementation cost of £40,700 yields a positive return on investment, 65.5%. The payback period is well within the payback period designated by the company; therefore it is reasonable to invest in an AIDC system.

Table II. Cost savings and implementation costs

(A) System Implementation Costs	
Hardware Costs (RFID)	
Cost of tags	£10,000
Cost of tagging items	£5,000
Reader	£2,000
Total	*£17,000*
Hardware Costs (DPM)	
Marking machine	£8,000
Reader	£1,500
Cost of marking items	£5,000
Total	£14,500
Hardware Costs (Barcodes)	
Label cost	£1,000
Cost of labelling items	£5,000
Printer	£2,500
Reader	£2,000
Total	£10,500
Software Costs (Thin Client)	
Integration Development	£ 8,000
Wi-Fi Access Point	£500
Wireless Survey	£700
Total	£9,200
Software Costs (Web Service)	
Integration Development	£ 22,500
Wi-Fi Access Point	£500
Wireless Survey	£700
Total	*£23,700*
(B) Annual Savings	
Reduction in inventory	£6,500
Time reduction during stock takes	£5,376
Efficiency improvement	£14,768
Total benefits	£26,644
Return on investment (B/A)	65.5%
Payback period	18 months

4. Summary

This research paper presented a methodology for calculating the AIDC ROI based on waste elimination. The applicability of the methodology was tested in a real business environment and yielded a positive ROI within a short term payback period. The results suggest that the use of process activity mapping with a view to eliminate non-value adding activities in discrete processes can determine the areas where AIDC can add value. In addition, it has been illustrated that the use of AIDC systems in discrete processes can improve the accuracy and timeliness of information and facilitate JIT practices through inventory and process cost reduction.

This case study involved a particular business environment and whilst it is acknowledged that ROI will vary significantly from organisation to organisation, it is anticipated that the methodology may be applied in different settings, as it can help potential adopters of AIDC technologies quantify the value and of an investment in an AIDC technology in a simple and straightforward manner. Using the fundamental concept of lean of eliminating waste, potential adopters will be able to examine their processes whilst assessing the ROI against their actual needs. This will aid to build a solid business case based on actual company data in order to obtain management commitment and adequate resources for the progression of the implementation.

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