Title: Challenges for Automatic Identification Systems in the Supply Chain

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Abstract:

This Article deals with Challenges for Automatic Identification Systems in the Supply Chain. In this article there are described the most often used Automatic Identification Systems that contribute to more effective information flow between individual elements of the Supply Chain. This article describes a potential way of integration of technologies AIDC (*Automatic Identification and Data Capture*) across the Supply Chain. The methodology for the selection of a suitable technological solution is described in a significant part of this article. As a suitable technological solution is understood the selection of proper AIDC technology, their combination respectively, based on pre-defined criteria.

Keywords: supply chain; RFID; radio frequency identification; AIDC; automatic identification and data capture; bar code; technology.

Introduction

Currently it is more and more clear that the latest technology is being introduced into all logistic activities with the objective to provide for an efficient flow of goods through the Supply Chain. This is happening regardless if this means only the monitoring, identification or evidence respectively, preparation of goods, payment for goods respectively. Majority of formerly executed manual acts have been or will be replaced, step by step, by automated systems of processing and identification as well as by wireless technologies providing for active tracking, finding, management of goods and execution of operations provided by logistics companies. Technology identified as *AIDC – Automatic Identification and Data*

Capture belongs among these systems - the systems most utilized for processing of goods and for management of logistic processes. This represents a group of various technologies used for automatic identification of items, data capture about these items having the capability to enter this data in an electronic form into enterprise information systems. According to Madleňák et al. (2013) the reason for their expansion is, in particular, the fact that in a majority of cases the *Automatic Identification and Data Capture systems are capable of working without any human intervention, which is then limited to scanning of goods, of items respectively, equipped with* AIDC identification/equipment (for instance bar code on foodstuffs or permissions to entry secured by RFID technology). Vítek (2009) has a similar view.

Number of automatic identification and data capture technologies (sometimes also identified as „automatic identification" or *„Auto-ID"*) are in their substance of an older date of development and they have seen a significant progress during years and therefore they are currently available to all users looking for the interaction between business processes and systems utilizing AIDC of electronic equipment. On the other hand some of the principles and techniques utilized for AIDC do not have such an overall introduction and utilization and this is primarily due to high introduction costs linked to implementation and maintenance into the company system or simply thanks to giving priority to an alternative/cheaper form of automatic identification (bar codes (QR codes) vs. RFID tags).

According to Ježek (1996) on general terms each system of automatic identification is composed from the following elements while these elements differ in their functions, in functions they are supposed to perform and also by application of those physics phenomena on which they are based:

- *Scanning equipment* – allows reading of the identification code, the symbols respectively, in the point of interaction among the tangible systems and information systems and its following translation into a suitable shape for further processing.
- *Code Bearer* – *serves* to capture the code symbol while this may be the product itself, part of the product or it is regularly attached to the product (for instance it is on the packaging, or it is a label/sticker, magnetic tape or magnetic stripe). It corresponds to the selected identification technology according to concrete conditions of application and it is usually physically linked to the object of identification
- *Program unit* – *it* represents equipment that makes it possible to store acquired data/information to programmable data storage however only in combination with automatic identification systems that are capable of utilizing programmable units.
- *Evaluation unit* – it is responsible for translation of the identified code into form understandable to a human being or to automatic evaluation and bringing about further activities. The evaluation unit is a part of the information system and it often provides for the feedback between the unit and the identified objects.

Prior to the introduction of suitable technology of automatic identification in a company it is essential to calculate with introductory costs needed for the implementation of the given technology but also with operations expenses directly depending on functions and activities

that are the reason for the implementation of this technology. The effective utilization of these individual technologies of automatic identification is thus finally based on physics principles and on concrete features that make the AIDC technologies different from each other. These are primarily the following attributes (Lukšů, 2001):

- Distance between the information medium and the scanning equipment
- The volume and the density of stored data
- The scope of scanned features
- Programmability
- The possibility of manual data entry
- Speed of reading
- Reliability
- Durability of the medium and the code marking
- Suitability for various work (more demanding) environments
- Safety and data protection

Based on the difference between the stated features and the physics phenomenon principle on which the concrete technology of automated identification is based we can classify the following methods, *Automatic Identification and Data Capture technologies respectively* (Ježek, 1996):

- Magnetic technology
- Biometric technology
- Optic technology
- Induction technology
- Radiofrequency technology

1. Automatic Identification Technology

The operation and the utilization of each Automatic Identification technology brings about certain pros and cons, both financial and technical, or of another nature potentially. In particular the costs of introduction of some technologies brings to the front less costly alternatives. Another significant factor that influences the decision which technology shall be used is the environment where the selected technologies shall be used and the physics phenomena influence related to them falling on principles and methods utilized by the individual automatic identification technologies used. Ultimately it is also essential and useful to pay attention to functional suitability of introducing any concrete technology. In the following sections of this chapter our attention shall be given to a brief description of the already mentioned types of *Automatic Identification and data capture technologies.*

1.1 Magnetic technology

Benadiková et al. (1994) characterizes magnetic technology as one of the Automatic Identification technologies utilizing magnetic methods based on the principle of magnetic coding of data on a coat/cover or Magnetic Stripe that are located on plastic cards/magnetic cards (See Figure 1) or some other magnetic data media while they are in the next step identified by means of magnetic scanner with digital circuit. A magnetic card is characterized by a long useful life and the strong advantage of a magnetic card (for instance in comparison with bar codes) is the possibility of repeated recording. On the other hand its strong advantage can become, under certain conditions, also its strong disadvantage because in case there is a certain record stored on the card then a very strong magnetic source is able to delete the card by means of involuntary magnetic induction in case it is close to the card. For this reason and also for the security of recorded data reason there is currently used a hybrid system based on the combination of a magnetic stripe and a programmable microchip (Madleňáková and Madleňák, 2012).

Figure 1: Pay card

Source: Jumia Travel

Utilization of this technology is justified in those areas where it is essential to precisely and correctly recognize encoded signs, for instance in retail, banking, health care, catering industry, travel industry, entry and attendance systems, safeguarding entry systems, libraries and similar.

Magnetic stripe's main characteristics, and it may be stated that in some case also the limitations of a magnetic stripe are the following (AIM Global, 2013):

- Easily implemented system of reading and entering data
- Low to medium memory capacity
- Low cost media used as data media and supporting hardware
- Large scale of safety improvements allowing the adaption to a range of specific needs and purposes
- In majority of cases the need to have stationary contact reading equipment

1.2 Biometric technology

Biometric technology utilizes people identification methods based on different physiology features and characteristics of individual people that allow to recognize and to distinguish a concrete individual – the bearer of the given biometric characteristics. These given characteristics are digitized after the scanning is done. This identification is done by comparing this information with the database that contains the information about individual persons (so called biometric template or pattern respectively). There are defined the following biometric automatic identification technologies:

- Identification of fingerprints
- Identification of hand geometry
- Authentication of hand palm veins
- Scanning of eye retina and iris
- Face recognition
- Signature recognition
- Voice recognition and voice analysis
- DNA identification

Ježek (1996) states that the disadvantage of the individual types of biometric technology is the fact that they do not produce print outputs. On the other hand they provide higher security and control and this is the main area of their implementation and utilization within attendance systems and entry systems. From the point of view of their practical introduction at the start these were very costly and technologically complicated technologies, however with time their costs have declined which has initiated their widespread introduction and step-by-step substitution of systems working on magnetic card principles. Currently we can see their dramatic development and applications used in the areas of security, identification and verification of electronic banking.

From among the above-mentioned biometric technologies of automatic identification and data collection it is the voice recognition technology that is now quite primarily used in the area of logistics, distribution, warehousing, mail services respectively (Zeman and Švadlenka, 2013). Among the main characteristics of voice recognition technology belong (Zeman and Švadlenka, 2013):

- Free eyes and hands when manipulating with goods which leads to higher productivity and performance
- High precision of the system supported by utilization of control numbers identifying a concrete good
- Ability to change the configuration of the system with the objective of efficient collection of data and adaption of data of various natures

- Specific protection of data based on user conditions

- Widening application basis, mainly with voice recognition systems

1.3 Optical Technology

Optical technologies of automatic identification are based on methods that utilize, as the main element of data and information transmission, light. The main principle is based on scanning reflected light from picture code that is being illuminated by a light source in the visible spectrum or the invisible spectrum. Among the most often used optical technologies are optical reading of marks (OMR – *Optical Mark Reading*), *Optical Character Recognition* OCR) and B*ar codes*. Each of these technologies has its specifics, technical solution and usage and advantages and disadvantages connected to each technology. Regarding its application in logistics, distribution and in postal sectors of higher importance are the Bar Code technologies and OCR. However with regard to providing for complexity it is essential to shortly speak also about other technologies.

1.4 Induction Technologies

The principle of induction technology functioning is in its core the same as the principle of radio-frequency identification, only with the difference that with the identification by means of induction method there happens so called *induction connection*. Utilization of induction technology makes it possible to reach reading distances in orders of tens of centimetres which we mark as *Low Range* or *Near Field Communication, so called NFC.* The tag includes chip that stores data and a coil that operates as an aerial. Reader generates high frequency magnetic field that penetrates the tag reel coil, there happens mutual induction of two reels (primary in the Scanner and a secondary in the Tag) and a consequent transmission of data.

1.5 Bar Codes

Bar Codes technology represents currently the most widespread technology of automatic identification and data collection in the world. This does not represent any new technology since the origins of this technology can be dated back to the 30thies of the 20th century.

Classification according to graphic expression represents the most utilized and the most spread categories of bar codes where we identify the following groups:

- *Linear bar codes* – they are also called 1D bar codes and currently they are the most known, the oldest and the most widely spread group of bar codes. From their construction point of view they comprise from only one row of lines and spaces while they are coded only horizontally. We can read them by means of reading pen, CCD scanner and laser. Among linear bar codes there belong for instance: EAN 8, EAN 13, Code 39, Code 93, Interleaved 2/5, Code 128, Codabar, and similar...

- *Two-dimensional bar codes* – or 2D bar codes. They originate by organizing the individual pieces in a matrix manner, usually into a square or rectangle shape while this organization allows storing larger volume of information than with the regular linear bar code. 2D bar codes cannot be scanned by a laser, but exclusively by a

scanner that allows to process picture processing by means of a camera with CCD (CCD – Array)/CMOS scanner. There belongs for instance: Aztec Code, Data Matrix, MaxiCode, PDF417 or QR Code.

- *Compounded (composite) bar codes* are created by a combination of linear and two-dimensional bar codes. The linear element is represented most often by the linear bar codes EAN 8, EAN 13, UPC A, GS1-128 or DataBar while it is possible to read them by means of 1D scanners (1D scanner in this case ignores the 2D element of the composed bar code). The two-dimensional element of the composed code may be of type CC-A or CC-B (alternative Micro PDF417), or respectively type CC-C (alternative PDF417) and that also in the case that the linear code is GS1-128 bar code, by CC-C (alternative PDF417) in case that the linear element is the GS1-128 bar code. Here belongs for instance: composite EAN 13 with CC-A, composite GS1-128 with CC-A composite GS1-128 with CC-C, composite all direction DataBar with CC-A and similar.

- Two-dimensional element of the *Compounded* code may be of type CC-A or CC-B (alternative Micro PDF417), respectively of type CC-C (alternative PDF417), and that in case the linear element consists of GS1-128 bar code. Here belongs for instance: composite EAN 13 with CC-A, composite GS1-128 with CC-C, composite all direction DataBar with CC-A and similar

- *3D Bar Codes* – with 3D codes it means colour 2D codes that can use the multicolour scale for further increase of data capacity and the reduction of area needed for the placement of the code. They have not seen any further spreading and their utilization, regarding the design, is primarily in the area of marketing. The most famous 3D codes are the Color-coded, HCCB (High Capacity Colour Barcode), or Ultra Code.

1.6 Radio Frequency Technology

RFID – *Radio Frequency Identification Technology is* ranked by professionals to be the second best regarding the development of technologies of automated identification that can be used in postal services (Madleňáková and Madleňák, 2012). Attention given to this technology, thanks to its introduction to postal and logistic services, is well earned. Despite the fact that on a global scale it cannot yet be a full-fledged alternative, nor it is considered to be a full-fledged replacement for bar codes technology, in many directions it already brings more options and advantages issuing from its application. However it remains to be true that currently, with regard to its quite high price (RFID tag, scanning equipment) and to high technology requirements compared to bar codes its application and its introduction is less massive and it is suitable more as a complimentary tool for automatic identification of larger transport units (containers, carrier boxes, mail bags, replaceable additions and similar). The main advantage this technology brings about is the possibility to programme tags, which allows their repeated use and also much larger volume of data possible to save.

The basic principle of *Radio Frequency Identification Technology is* the transfer of the signal by means of electromagnetic waves, their modulation and utilization of physics characteristics of electromagnetic waves for spreading in an open space. The source of primary signal is the so-called Reading equipment *(so called RFID reader or reader)* that comprises of transmitting and receiving circuit with a decoder and antennae. In case of such need the reader

can be equipped in some cases also with its own operation system providing basic software functionality. The recipient of the signal is a transponder, so-called RFID tag which is actually an electronic memory circuit including a silicon chip and an antennae for reception and tuning of the signal. The readers transmit a high frequency signal (extent kHz, MHz or GHz) tuned to the same frequency as the individual chips' circuit, so that when RFID tag gets to the band of the transmitting reader it accepts the signal by means of the antennae and the oscillating circuit, then it modulates it and sends it as a secondary modulated signal back to the reader. The modulated signal is determined for transmission of a tag unique identification number *EPC (Electronic Product Code)* or to the content of the tag data memory.

Szafrański (2011) states that in the framework of supply chains the international market step by step gets to the implementation of RFID technology. For instance large business network Wal-Mart was one of the first subjects that decided to use this technology for cooperation with its suppliers.

2 Challenges for automatic identification systems in the supply chain

The most important benefit of automatic identification technologies is that they provide effective information flow in the supply chain. The individual elements of the chain must have precise and up-to-date data and AIDC technologies are those agents who support this requirement. Harrison and Hoek (2005) mention tools, by means of which, this situation can be reached. These tools are E-Business, ERP (Enterprise Resources Planning) and RFID.

Due to more and more complex globalisation supply chains are more and more complex - Bowersox et al. (2013), Waters (2010), Mangan and Lalwani (2016) and also Coyle et al. (2016) point this out in their articles.

As a more complex chain is understood a chain that has more elements that are located in various parts of the world and thus there are larger distances between these elements. From this issues the requirement of a more complex security of information flow. Here the AICD technologies have a very large potential. The most important thing here is to provide for the coordination, standardization, integration and cooperation in logistic chains 'elements with the objective to obtain synergy effects as it is seen in Figure 2.

**Figure 2: Prerequisites for synergistic effect**
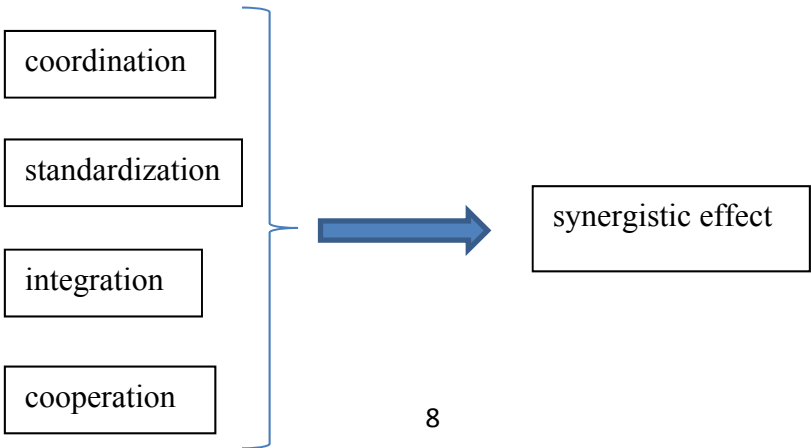
Source: Authors

The most sophisticated system can be seen currently in the automotive industry. The prove of that is the functioning of technology Just in Sequence (JIS) that is, among other things, based on utilization of AIDC, EDI, ERP technologies and on other technologies.

Other industry sectors try to adopt logistic systems from the automotive industry, but in a modified form since each industry sector has its specific features.

In the framework of the process of achieving synergistic effect „standardization" is very important, both in selecting the AIDC technology and in their parameters (see Figure 3).

Figure 3: Levels of integration of AIDC technology in supply chain
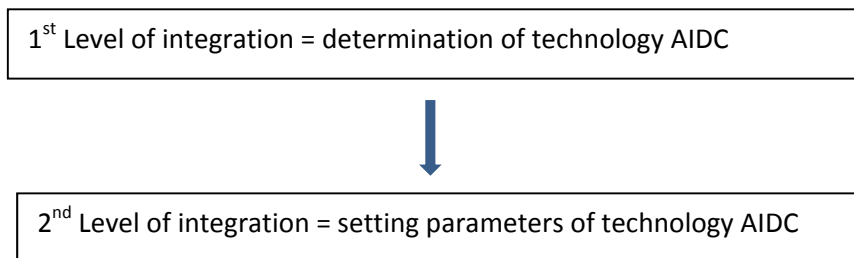
Source: Authors

2.1 Methodology for selection of a suitable technological solution in the AIDC Framework

In the following table there is drafted a methodology for the selection of a suitable technological solution in the framework of AIDC with the objective to make tracking of shipments transported within the supply chain. This improved efficiency is possible to understand as achieving the optimal state of meeting qualitative parameters of tracking of shipments during the transport process[1] with investing relevant resources.

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[1] These parameters stand for reliability, accuracy, speed, intact shipment, price for delivery and last but not least sufficient amount of data on the transported shipments

Table 1: Methodology for choosing suitable technology solution in the framework of AIDC

Methodology Phases	Methodology Main Points	Individual Steps
A. Phase A – the need to solve a problem	A.I.	The need to solve a task/problem -> define the objective – to make tracking of shipments within supply chain more effective
	A.II.	Definition of dates/responsibilities
B. Phase B – Preparatory Phase	B.I.	Analysis of the existing way how problems are solved in a given company
	B.II.	Analysis of the existing way how the researched into issues are solved
	B.III.	Evaluation of the analysis
	B.IV.	Precise definition of goal/s
C. Phase C – Choosing optimal alternative	C.I.	Identification of Alternatives for technological solutions
	C.II.	Identification of criteria for the optimal alternative selection
	C.III.	Definition of the level of importance of the individual criteria
	C.IV.	Selection of the optimal alternative
	C.V.	Detailed specification of the selected technology solution
	C.VI.	Financial evaluation of the selected economic solution
D. Phase D - Implementation	D.I.	Decision on the conditions of pilot project implementation including the setting of dates, time-schedule and responsibilities
	D.II.	Implementation of the pilot project
	D.III.	Evaluation of the pilot project
	D.IV.	Decision on introduction of the selected technological solution

Source: Authors

The methodology for selection of the most suitable technological solution with the objective to make tracking of shipments in supply chain more effective is divided into four phases. In Phase 1 (Problem/Task Solution Phase) it is first of all essential to set a goal the fulfilment of which shall provide for rectification of the given problem or for fulfilling the given goal. The objective here is to make tracking of shipments more effective in the supply chain. Improved efficiency in shipment tracking thus represents both the rectification of the problem, such as lost shipments, as well as getting total information about shipment transport from handling the shipment to transport to delivery of the shipment to the customer and that done by means of an effective tracking process-the tools of this process are the automatic identification technologies. It is essential that such goal is concrete, measurable, and realistic and has a set deadline. Based on this defined objective it is further essential to set deadlines or in other

words to make a schedule and to assign responsibilities for meeting of this concrete goal in the defined deadlines and times. Phase 2 smoothly comes after Phase 1.

In Phase 2 (The Preparatory Phase) the first step is to execute an analysis of the existing way that issues are solved with the objective to identify opportunities for improving the existing situation. Identification of such opportunities is based on this detailed analysis of the existing manner how things are done in a concrete company including identification of such facts as what type of shipments are tracked, what technology solution is used and to what extent within the network with the objective to identify the cause/ses of the given problem or to define opportunities for meeting the defined goal. After this detailed analysis there comes analysis of the existing manner of solving the researched issues at home and abroad. Both the analysis of the existing system of solutions in a given company and the analysis of the existing manner of solving the researched issues at home and abroad are consequently evaluated. Part of this solution is also finding out whether results of the existing situation analysis at home and abroad can contribute to concrete issues and tasks of the given company, respectively look at how their approaches can be applied to a specific environment and to conditions of the given logistic services provider. Possible result of both these analysis maybe the fact that the results of these analyses do not support the generally defined goal which means that conditions for these analyses were not correctly defined and thus it is essential to amend such conditions and to execute both of the analyses again. The required result of the evaluation stage of both analyses is that results of the executed analyses are in accord with the set objective from the first phase of these analyses. Based on the evaluated analyses the goal as already defined in the first phase is more specified in a more detailed way.

After Phase 2 there comes Phase of optimal alternative selection. The first step in this phase of methodology is the identification of the individual alternatives of the technological solutions. The individual automatic identification technologies, their combinations respectively, are understood to be the alternatives. Their summary is in Table 2.

Table 2: AIDC technologies

Technology	Characteristics	Form of implementation
Bar code	EAN 8 – 8 digit number, EAN 13 – 13 digit number	gummed label, printed
GTIN	GTIN 14 (EAN 128, ITF 14)	gummed label
SSCC code	18 digit number	gummed label
Data matrix	Capacity: 3116 Numeric capacity, 2335 Alphanumeric capacity	gummed label, etching, impressing, branding, engraving, printed
QR code	Capacity: 7089 Numeric capacity 4296 Alphanumeric capacity	gummed label, printed
RFID technology	Passive and active tags, frequencies LH, HF, UHF, microwave, ability to read multiple tags at once	gummed label (smart label), cards, key cases, bracelets, plastic encapsulation

Source: Authors

In the second step there are identified criteria for the selection of the optimum alternative. In this second step there is further defined how/if the individual alternatives meet such criteria or not. In the framework of the researched issues this concerns primarily the technical-technology criteria, such as environmental impacts in such categories as dustiness, humidity and similar on the individual technological solutions alternatives, as well as on reading errors levels, volume of data for entry and similar. Another significant group of criteria are financial criteria such as investment and operations costs related to the implementation of the future selected optimal alternative. The considered criteria are stated in Table 3.

Table 3: Identified Criteria for the Selection of Optimal Alternative

Technical – technology criteria
Size of Code (Number of Information to store in the Code)
Environmental impact (humidity, dustiness) on the Code
Susceptibility of Code to Damage
Speed of Reading
Visibility of Code=demands in the area of manipulation with shipments
Financial Criteria
Investment Costs
Operation Costs

Source: Authors

Prior to the selection of the optimum alternative it is also essential to define the importance of the individual criteria and that is done due to different importance of the individual criteria related to the solved issues. For the identification of alternatives, criteria and similar it is generally possible to make use of some methods such as is for instance brainstorming or a morphology analysis. The example of criteria evaluation for the individual AIDC technologies, their combinations respectively, is stated in Table 4.

Table 4: Criteria evaluation of individual AIDC technologies

Technology	Code size	Technical and technological criteria			Damage	Scan speed	Manipulation	Economic criteria	
		Operational environment						Investment	Operating
		Humidity	Dustiness	Presence of metal					
Bar code	✗	✗	✗	✓	✗	✗	✗	✓	✓
Data matrix code	✓	✓	✓	✓	✓	✗	✗	✓	✓
QR code	✓	✓	✓	✓	✓	✗	✗	✓	✓
RFID technology	✓	✗	✓	✗	✓	✓	✓	✗	✗
GTIN	✗	✗	✗	✓	✗	✗	✗	✓	✓
Bar code + RFID technology	✓	✓	✓	✓	✓	✓	✓	✗	✗
Data matrix code+RFID technology	✓	✓	✓	✓	✓	✓	✓	✗	✗

| QRcode + RFID technology | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✖ | ✖ |

✖ negative evaluation within given criteria

✔ positive evaluation within given criteria

Source:Authors

The following step is the selection of the optimal alternative that means of suitable technological solution for fulfilling the given task or for solving a concrete problem/problems. During the selection of the optimum alternative it is also possible to apply a number of methods. Suitable methods are a multi-criteria analysis or method TOPSIS. After selection the optimal alternative this alternative, or in other words the selected technological solution, shall be submitted to a detailed technical-technology specification with the objective to define exactly this technological solution and that is done for the reason that these technologies of automatic identification have various forms of execution, size of code and similar and it is essential to take into consideration the specific environment of the given industry sector. The selected technological solution must be also assessed from the financial point of view in order to be able to define whether investment into the selected technological solution and the expected contribution shall be beneficial for the given provider of logistic service. For this financial assessment the following methods are useful methods - Cost/Benefit Analysis, Net Present Value, Payback Period, or Internal Rate of Return. The economic evaluation shall be applied under the last step of this phase. After the detailed specification of the selected technology solution is done and its financial evaluation is also done it shall be clear whether this selected solution respects the defined criteria. If the selected technology solution does not respect this defined criteria it is essential that a second best technology solution be selected. This second best solution is then submitted to detailed specification and to financial evaluation. The objective of this stage of this methodology is to identify such a technology solution that shall meet the defined criteria.

The last phase is the Implementation phase. The objective of this phase is to, via a pilot project, decide if and to what extent the selected technology solution shall be implemented under the conditions of the logistic services provider. For this purpose it is essential to decide about the conditions for implementation of a pilot project including its extent (technology and financial=to what size sample/what number of shipments it shall be applied), terms/deadlines – time schedule or responsibility of individual participating persons. Consequently this pilot project is implemented and after its implementation it is evaluated in such manner that it is defined whether the results of the pilot project meet the defined objective. If the defined objective is not met it is essential to make changes to the implementation conditions of the pilot project and this changed pilot project is re-implemented and re-evaluated. The objective is that the results of the pilot project meet the defined target. Based on the evaluation of the pilot project it is decided about the introduction of the selected technology solution including its extent. The selected technological solution must be regularly evaluated and innovated so that shipment-tracking efficiency is ensured during the transport process. For this purpose it is

possible to apply PDCA cycle (P-Plan, D – Do –execution, C –Check – checking, A – Act – action) that means process of continuous improvement.

The following methods are applied under the individual phases of the methodology:

- A. I. (The need to solve the task/issue -> definition of the objective), B. V. (Precise definition of the objectives – **Morphology Analysis, Methods SMART,**

- B. I. (Analysis of the existing way how problems are solved in the given company), B. II. (Analysis of the existing way how problems are solved in the given company in the CR/abroad) – **Collection of Information, Analysis**

- B. III. (Evaluation of the analysis in the given company in the CR/abroad) – **Synthesis**

- C. I. (Identification of alternatives of technological solutions) – **Brainstorming, Morphology Analysis, Proposals Pair Relations Method**

- C. II. (Identification of Criteria for the selection of the Optimum Alternative), C. III. (Definition of Importance of the individual criteria) – **Brainstorming, Sati's method experiment**

- C. IV. (Optimum alternative selection) – **TOPSIS Method**

- C. V. (Detailed specification of the selected technology solution) – **Laboratory experiment**

- C. VI. (Financial evaluation of the selected technological solution) – Net Present Value, **Payback period**

- D. III. (Evaluation of the Pilot project) – **Comparison with the defined targets**

The above-presented methodology allows for selection of suitable AIDC technology that shall ensure effective tracking of shipments transported within the supply chain.

Conclusion

Current trend is larger and larger rate of utilization of AIDC technologies. One of the reasons is larger and larger globalization of supply chains and thereby competition that leads to more and more often used application of so called „lean logistics" that has as its objective to reduce waste, both material and financial, as well as time waste. Thanks to AIDC technologies there are shorter reactions in the supply chain and that is the source of shorter delivery times and of more precise information about the movement of shipments (on-line tracking), of shipment

and transport means. With growing technological advances there come new possibilities to use AIDC technologies, their combinations respectively. In order to find the proper technology solution in the framework of AIDC for more effective tracking of shipments transported within supply chain the methodology stated in this article should help.

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