The Discrepancy between Auto-Id Projects for sustainable Development

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Abstract: - At the beginning of this paper is to be found the design of a new method for process visualization specialized for Auto-ID projects. Existing methods are not taking into account all aspects, which need to be considered. Also key figures for easy quantification and comparability among different projects are developed. Afterwards the new development method is applied on two strong different case studies to cover a wide range of application.

Key-Words: - radio frequency identification system; process visualization method; tag; process chain paradigm; key figures; material flow; information flow; sustainable development, Auto-ID, case studies.

1 Introduction

Auto-ID and sustainable development is this something, which can go along with each other, or can it not exist simultaneously? First the definition for sustainable development has to be considered in order to take a closer look:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and

the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." [1]

Auto-ID is not considering any need of the world's poor but it is saving trees and paper if it is used in closed system, e.g. the transponder can be used several times. An example for this system can be found in the first case study.

On the other hand (second part of the definition) Auto-ID should meet the present and future needs. Reducing mistakes and accelerating the output of goods by the help of Auto-ID technology is certainly something, which is underlining this idea. An example for these kinds of improvements is given in this paper by the second case study.

2 Preliminaries and Problem Formulation

How can an Auto-ID project, here a case study completely be described? A certain tool or method is needed to record all information and make the information be quantifiable and comparable – this can be achieved by a process visualization method.

At the moment no process visualization method exists which allows a complete process for an Auto-ID process recording taking into account material- and information flow, assistive equipment, resources as well as IT-Interfaces. Normally existing methods are focusing on a later process modeling which make them complex. Thus the complexity and necessary deep understanding of the process are obstructive for a process recording, which should be fast, and time efficient. In addition to that the risk of recording an incomplete actual state, which can cause time- and money consuming repeating recordings to record all information exists. [2]

The following subchapters of this paper will describe at first the process how a new process visualization method was developed shortly and define where in the existing landscape of methods for process visualization it should be situated. Afterwards details how the method is structured and should be used will be given. [3]

This paper is answering the open questions of technical kind such as chosen hardware and comparability of different applications with the help of two case studies: One case study for a small batch application and one case study for a mass production. The developed process visualization method will be applied on both case studies and the results will be compared afterwards.

3 Glauto Process Chain Paradigm

3.1 Generalities

A new method for process visualization will be developed which is called “Glauto Process Chain Paradigm”. It will feature an integral process recording with respect to material- and information flow, assistive equipment, resources as well as IT-Interfaces, which make it more, specialized for Auto-ID processes. It will also feature logical and conditional correlations because information deficits are a problem for planning and controlling of processes [4]. Glauto will additionally feature interfaces to IT systems as well as material- and information flow and the “flow of help” which mainly is in industrial environment transportation with different vehicles. Especially Glauto will focus on the combination of material- and information flow together with existing IT systems in order to use the full potential of the Auto-ID technology which can only be used when backend systems combines all in- and outputs to a powerful system. [3]

Glauto will be developed as a standardized method. It will mainly be based on the visualization of (sub) processes with a few logical operators for material and information flow. The name “Glauto” consists of a combination of the first two letters of “Gleser “and the “Auto” without ID to describe its aim to be specialized for Auto-ID applications. [5]

Fig. 1 shows a diagram with three aspects namely “Logistics & Production”, “Business Process Management” and “IT Soft- & Hardware”. To be found in the diagram are commonly used process modelling and / or process analysing tools. The goal for Glauto is to position it as a universal tool for all Auto-ID interfaces in the middle of all three considered aspects as there is a need to record processes, consider interfaces to existing IT systems as well as being able to rate processes in the sense of economical aspects. [3]

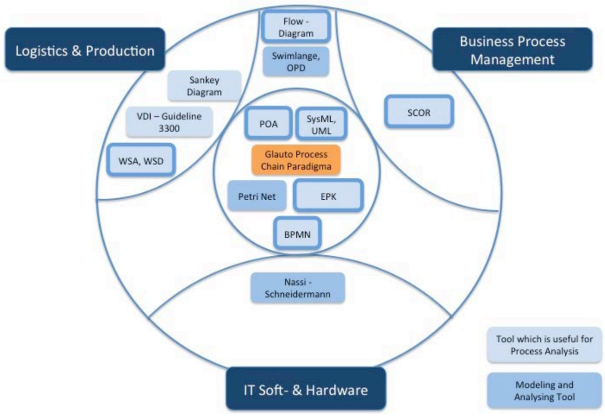

Fig. 1 Classification of Methods for Process Visualization (based on [2])

3.2 Definitions of Glauto Content and Process Key Figures

Next is to be found the definition of the processes used in the Glauto process chain paradigm

- Main Process

A main process is a sequence of interdependent and linked procedures, which, at every stage, consume one or more resources (employee time, energy, machines, money) to convert inputs (data, material, parts, etc.) into outputs. These outputs then serve as inputs for the next stage until a known goal or end result is reached [6]. A main process can consist of n sub processes and m operation block diagrams, with n < m.
[5]

- Sub Process

A sub process is a set of activities that have a logical sequence that meet a clear purpose. A sub process is a process in itself, whose functionality is part of a larger process [7]
[5]

- Operation Block Diagram

An operation block diagram is the smallest unit, belonging to a sub process and a main process in the Glauto process chain paradigm. It is characterized by its process type and contains a symbol for the type of operation.
[5]

Next is to be found a sample for process visualization with Glauto. It contains the operation block diagrams as well as basic operations and connecting and logic symbols. On the bottom of this diagram is the flow of material situated, above the resources which means here should be situated all supporting processes and resources. Above is to be found the flow of information, which is often triggered, by the flow of material but sometimes it can be the other way round. On the top of the

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diagram (Fig. 5) is the IT interface situated, which is kind of similar to the resources but is meant to be filled by supporting IT processes or IT resources. Potential for improvement can be visualized by using a blizzard and next to it the improvement in textual description.
[5]

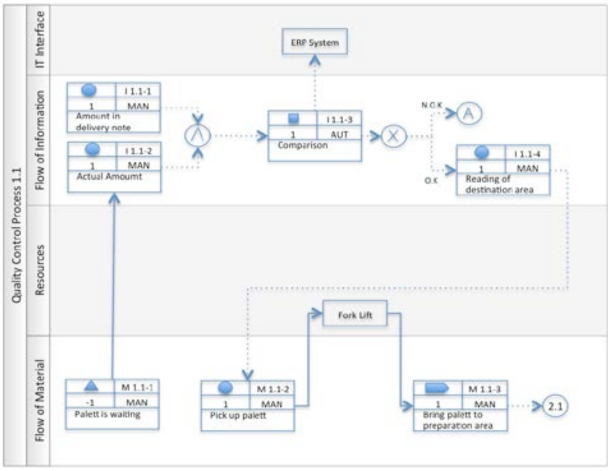

Fig. 2 Sample for a Glauto process chain plan with manual checking of goods at arrival (based on [2])

Next are to be found the definitions for the process key figures which can be used to qualify and compares Auto-ID application.

- Quality of material flow

The quality of the material flow for a sub process consisting of n block diagrams can be understood as below.
Glauto quality for material flow for a sub process is defined

$$GQM_{x.y} = \left[\sum_{j=1}^{n} Y_{x,y-j}\right] \Big/ n \; ; x, y = const \tag{2}$$

$$GQM \in \mathbb{Q} \; ; Y \in \{-2, -1, 1, 2\} \; ; j, n, x, y \in \mathbb{N}_{>0}$$

where

$M_{x,y}$	sub material flow process,
GQM_x,	Glauto quality for material flow and sub process $M_{x,y}$,
$Y_{x,y-j}$	value of the block diagram,
j	counter variable,
n	number of counted block diagrams,
x	counter variable,
y	counter variable.

[5]

- Quality of information flow

The quality of the material flow for a sub process consisting of n block diagrams can be understood as below.
Glauto quality for information flow for a sub process is defined

$$GQI_{x.y} = \left[\sum_{j=1}^{n} Y_{x,y-j}\right] \Big/ n \; ; x, y = const \tag{3}$$

$$GQI \in \mathbb{Q} \; ; Y \in \{-2, -1, 1, 2\} \; ; j, n, x, y \in \mathbb{N}_{>0}$$

where

$GQI_{x,y}$	sub material flow process,

- Glauto quality

The term Glauto quality GQ should be understood as a combination of GQM and GQI. The weighting of GQM and GQI is equal.

$$GQ = [GQM + GQI]/2 \qquad GQ, QGM, QGI \in \mathbb{Q} \tag{4}$$

where

GQ	Glauto quality,
GQM	Glauto quality for material flow,
GQI	Glauto quality for information flow.

[5]

- Degree of Automation

First of all values for the operation block diagram need to be defined. We already defined values for the operation block diagram itself (see chapter III B) but further more a definition of the variable Z (middle right of operation block diagram – Fig. 4.) has to be made in order to generate a number for automation degree.
Automated operation: Z = 1, manual operation: Z = 0.
The general form of degree of automation DoA is defined

$$DoA = \sum_{j=1}^{n} Z_j \; / n \; [\%] \tag{5}$$

$$DoA \in \mathbb{Q} \; ; Z \in \{1, 0\} \; ; j, n \in \mathbb{N}_{>0}$$

where

DoA	degree of automation,
j	counter variable for information flow,
Z_j	value of the operation for
n	number of counted block diagrams.

[5]

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4 Case Studies

In this chapter two case studies are to be found which will be described in the following in detail.

4.1 Auto-ID in Small Batch Production: Case Study Manufacturing of Special Tools for the Metal Cutting Industry

The first case study is a worldwide operating company, which produces tools for metal cutting. Standard products are produced at other locations in the world. The German subsidiary does produce special tools. As it is special the average order quantity is one or two. Before the product goes into the production department it has to be designed and the work preparation department has to set the order of working steps and has to choose the type of raw material. After these steps the product goes into production where an RFID systems should add benefit and minimize as well as prevent errors. Fig 3 shows the primary goals for this case study [8].

Fig. 3 Primary goals for an Auto-ID introduction for the small batch production [8]

Next is to be found the hierarchic process level model for this case study (Fig. 4). The considered part for this case study is production. It is the first step of the Glauto process chain paradigm. In order to keep the focus on the technical aspects this rough overview about the process itself is only included in this paper. [6]

Fig. 4 Hierarchic process level model for the small batch production [8]

In the following details for the designed system is to be found.

Selection Frequency Range

Based on the standardization and that connected low costs for hardware the frequency range of 13.56 MHz is chosen. The influence of the contact with metal is just negative when direct contact occurs. But it can also be used for increase of the reading distance by a smart reflection.

Selection Transponder

Based on low acquisition costs and the possibility to print the box numbers directly would it be adequate to use "smart labels" on trial. When the robustness is not enough it could be switched on plastic coated transponder in keychain design. Therefore no exchange of the hardware is necessary. But robustness is certainly a factor, which can make RFID more favourable than a Barcode. RFID-Transponders can resist water, dirt, direct sunlight, salty air and aggressive environment influences. Barcodes often cannot resist these influences.

Selection Reader and Antenna

Solid installed readers with a flat table aerial on which the box is placed should be used here. As a supplement to the solid installed readers also mobile readers can be introduced or can be added later on. This would be good to display the delivery date, the production order number or something like that. For this hardware some additional programming needs to be done and the IT structure has to be converted to it because mobile readers are provided with data via WLAN.

Next is to be found the possible and the chosen technology for this application. The chosen technology is marked in yellow.

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Table. 1 Conception summary

Frequency	LF	HF	UHF	MW
Energy Supply	Passive	Semi passive	Active	
Data storage	Read-only	EEPROM	FRAM	RAM
Type of coupling	Capacitive	Inductive	Backscatter	
Design	Disc transponder	Glass transponder	Smart label	Chip card
Reader	Handheld	Gate	Tunnel	Table integrated

Calculation of Glauto Process Key Figures

In this chapter is to be found data and key figures for the main processes, two and three and four which consists of five sub processes as well as four main processes. The other processes (see Fig. 4) are not within the scope for this case study because of being out sourced or are not executed in the German subsidiary. Key figures are presented at main process level (no sub process key figures) due to readability and space restrictions.

Quality of material flow

2. Design (main process)

$$GQM_2 = \left[\sum_{j=1}^{1} Y_{2-j}\right] \Big/ 1 = 1 \qquad (6)$$

3. Production (main process)

$$GQM_3 = \left[\sum_{y=1}^{5} GQI_{3,y}\right] \Big/ 5 = 1{,}28 \qquad (7)$$

4. Storing and packing (main process)

$$GQM_4 = \left[\sum_{y=1}^{2} GQI_{4,y}\right] \Big/ 2 = 2 \qquad (8)$$

Complete process

$$GQM_{tot} = \left[\sum_{z=1}^{3} GQI_z\right] \Big/ 3 = 1{,}43 \qquad (9)$$

Quality of Information Flow

2. Design (main process)

$$GQI_2 = \left[\sum_{j=1}^{7} Y_{2-j}\right] \Big/ 7 = 1{,}14 \qquad (10)$$

3. Production (main process)

$$GQI_3 = \left[\sum_{y=1}^{5} GQI_{3,y}\right] \Big/ 5 = 0{,}99 \qquad (11)$$

4. Storing and packing (main process)

$$GQI_4 = \left[\sum_{y=1}^{5} GQI_{4,y}\right] \Big/ 5 = 1 \qquad (12)$$

Complete process

$$GQI_{tot} = \left[\sum_{z=1}^{3} GQI_z\right] \Big/ 3 = 1{,}04 \qquad (13)$$

Glauto Quality

$$GQ_{tot} = [GQM_{tot} + GQI_{tot}]/2 = 1{,}235 \qquad (14)$$

Degree of Automation

2. Design (main process)

$$DoA_2 = \left[\sum_{j=1}^{8} Z_{2-j}\right] \Big/ 8 = 0\% \qquad (15)$$

3. Production (main process)

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$$DoA_3 = \left[\sum_{y=1}^{5} DoA_{3,y}\right] \Big/ 5 \ = 3{,}1\% \qquad (16)$$

4. Storing and packing (main process)

$$DoA_4 = \left[\sum_{y=1}^{7} DoA_{4,y}\right] \Big/ 7 \ = 0\% \qquad (17)$$

Complete process

$$DoA_{tot} = \left[\sum_{z=1}^{3} DoA_z\right] \Big/ 3 = 1\% \qquad (18)$$

The Interpretation of the key figures is to be found in chapter 4.3.

4.2 Auto-ID in Bulk Applications: Case Study European Logistics Centre for Textile Production

The considered company is a Swiss company, which produces outdoor- and mountain clothing and -equipment. The company is specialized in the high quality, premium sector and is trying to be the technology leader. 55% of the products are produced in Asia or in Europe. The considered site in Germany is the European logistics centre. The complete logistic is orientated on the on time provision on commissioned and packed goods for the customers. The core of the logistic system is the Dematic multi-shuttle storage system. Cardboard boxes and cases are stored in it for commissioning. When they are needed they are automatically delivered to the picking places. An automatic small parts storage, which is constructed as a high-bay warehouse, is the replenishment for the multi-shuttle storage. [6]

Fig. 5 Primary goals for an Auto-ID introduction for bulk application [8]

Next is to be found the hierarchic process level model for this case study (Fig. 6). The considered part for this case study is storing and packing. It is the first step of the Glauto process chain paradigm. In order to keep the focus on the technical aspects this rough overview about the process itself is only included in this paper. [8]

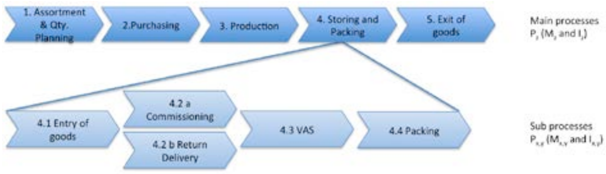

Fig. 6 Hierarchic process level model for bulk application [8]

In the following details for the designed system is to be found.

Selection Frequency Range

Based on the standardization of the ultra high frequency range in 2014 for logistics and additionally the desired long reading distances and the desired reading speed the frequency range of 868 MHz is chosen. The transponders can be read in distances up to several meters with the backscatter technology, which is need for this application.

Selection Transponder

Based on low acquisition costs and the possibility to print labels directly would it be adequate to use "smart labels" in the read only variant. With the backscatter technology also bulk reading and anti collision is possible, which means up to 500 transponders can be read in a few seconds. In this application approx. 3 millions transponders are needed each year, if tagging is done on article level. Thus the transponders have to be as cheap as possible to gain economical usage. With smart labels the price is in 2014 approx. 0,1 €/ pc. for the needed quantity of transponders. They can be easily printed additionally with a barcode and can replace the barcode that is used now.

Selection Reader and Antenna

For the European logistic centre three different types of reader will be used as there are:

1. Tunnel reader at the conveyer belts at 4.1 entry of goods and 4.2 a commissioning, which automatically checks the packed goods.

2. For the reworking places at 4.1. entry of goods and 4.2 solid installed readers with a flat table aerial on which the box is placed should be used. The antennas can be mounted under the table.

3. Optional handheld readers can be used for 4.2 b return of delivery and 4.3 VAS (Value added services) because pallets have to be read. The advantage is that there is no need for manual counting and booking of goods.

Next is to be found the possible and the chosen technology for this application. The chosen technology is marked in yellow.

Table. 2 Conception summary

Frequency	LF	HF	UHF	MW
Energy Supply	Passive	Semi passive	Active	
Data storage	Read-only	EEPROM	FRAM	RAM
Type of coupling	Capacitive	Inductive	Backscatter	
Design	Disc transponder	Glass transponder	Smart label	Chip card
Reader	Handheld	Gate	Tunnel	Table integrated

Calculation of Glauto Process Key Figures

In this chapter is to be found data and key figures for the main process four which consists of five sub processes. The other processes (see Fig. 7) are not within the scope for this case study because of being out sourced or are not executed in the European logistics centre. Thus key figures for the complete process cannot be presented here. Key figures are presented at main process level (no sub process key figures) due to readability and space restrictions.

Quality of material flow

4. Storing and packing (main process)

$$GQM_4 = \left[\sum_{y=1}^{5} GQI_{4,y}\right] \Big/ 5 = 0{,}94 \tag{19}$$

Quality of Information Flow

4. Storing and packing (main process)

$$GQI_4 = \left[\sum_{y=1}^{5} GQI_{4,y}\right] \Big/ 5 = 1{,}2 \tag{20}$$

Glauto Quality

$$GQ_4 = [GQM_4 + GQI_4]/2 = 1{,}07 \tag{21}$$

Degree of Automation

4. Storing and packing (main process)

$$DoA_4 = \left[\sum_{y=1}^{5} DoA_{4,y}\right] \Big/ 5 = 21{,}22\% \tag{22}$$

The Interpretation of the key figures is to be found in chapter 4.3.

4.3 Auto-ID in Small Batch Production and in Bulk Application: Comparison

Both case studies are designed to reach different goals (see Fig. 3 and Fig. 5). Also the structure of both systems is quite different. The first case study is working with a closed system (reuse of the transponder) and the second case study is working with an open system (receiving transponder from supplier and sending transponder to customer). Also for the first case study many improvements are possible due to a low degree of automation (see Fig. 9). In contrast to that the second case study has a very high degree of automation wherever it is economically efficient, especially in the sub process commissioning (see Fig. 11). In addition to that the Glauto quality of information flow for the main process 4 storing and packing is also higher (16,67 %) which also indicates automatic processes (see Fig. 8 and Fig. 10).

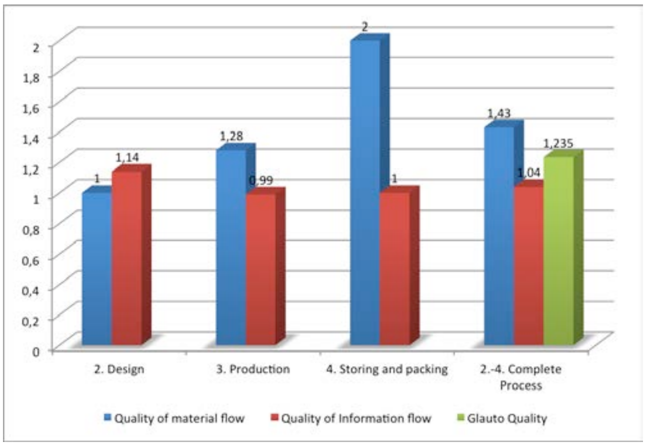

Fig. 8 Several process key figures for the first case study: small batch production

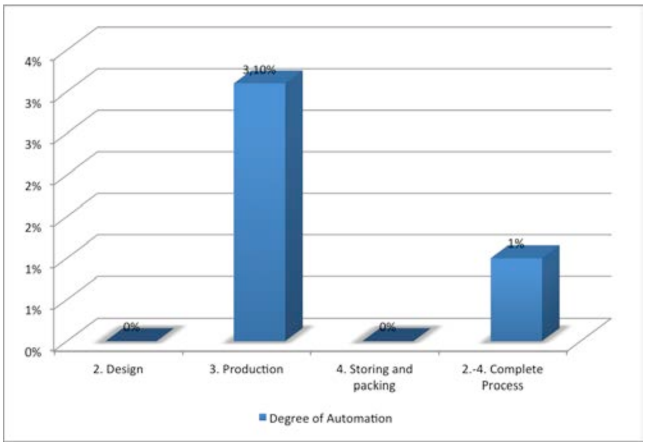

Fig. 9 Degree of automation key figure for the first case study: small batch production

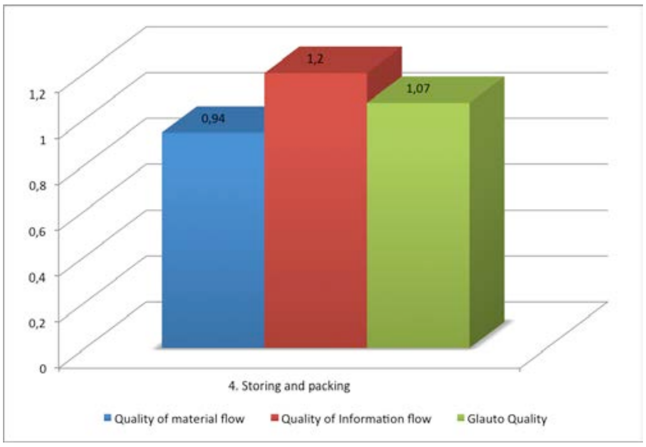

Fig. 10 Several process key figures for the second case study: bulk application

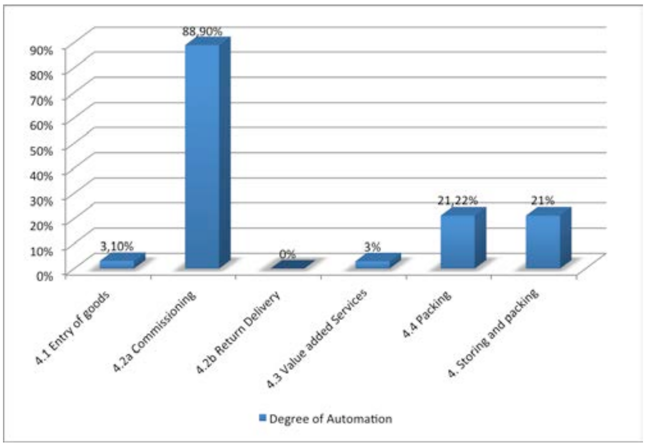

Fig. 11 Degree of automation key figure for the second case study: bulk application

4 Conclusion

With the development of a specialized process visualization method for Auto-ID projects is now possible to quantify and compare different projects with each other. Another big advantage with the Glauto process chain paradigm is the structured way or workflow of noting down each sub process (see Fig. 2). With its logical connectors it is close to the thinking when programming something, which should make it easier for IT experts to program the IT structure for an Auto-ID application especially in large projects. The key figures themself help to recognize potential for improvement whether it to be found in the material- or in the information flow. In addition to that the key figure degree of automation might also help for discussion if more automation should be invented in a company.

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Concluding this the discrepancy between different Auto-ID projects can be made visible with the help of the Glauto process chain paradigm. There can be no general statement if it leads always to a sustainable development but Auto-ID projects can help to achieve sustainable development.

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