THE MODERN STORAGE EQUIPMENT WITH EMPHASIS ON INNOVATIONS AND RISKS

VERA PELANTOVA[1], EVA SIROVA[2]
[1]Technical University of Liberec, Faculty of Mechatronics, Informatics and Interdisciplinary Studies, MTI
[2] Technical university of Liberec
Faculty of Economics, KPE
Czech Republic
DOI : 10.17973/MMSJ.2018_03_2017108
e-mail: eva.sirova@tul.cz, vera.pelantova@tul.cz
A lot of the research space is devoted to the design and the use of major production equipment in publications. Minor equipmentis neglected. Large stocks are in decline from a managerial position. However, their new role is shown due to changes in the substantial neighbourhood.
The article deals with the important issue of the storage equipment in connection with the automation. The case study shows the composition and the status quo of the storage equipment in organisations, including elements of the automation and of the diagnostics. It deals with the questions of innovations and also with the identification of potential risks in the area. There are included fundamental analyses. In conclusion, the article presents a set of recommendations for ensuring of the quality of operation of the storage equipment.
KEYWORDS
storage equipment, store, automation, innovation, risk, Industry 4.0, organisation

1 INTRODUCTION

A storage equipment and a whole warehouse economy leads out of main material flows. Therefore, the attention is not given to this aspect. However, the current development of equipment and organisational arrangement of organisations again groves. Whole pallet of risks affects again. The question is, what the status quo of storage equipment mainly is used now?

2 LITERATURE REVIEW ON THE STORAGE EQUIPMENT AND ITEMS

Innovative aspects rather of a technological nature are generally described, for example, in the article [Gawer 2014]. This is a literature review, but it also opens the imaginary door to the storage equipment. This article identifies that an innovation management should take place within an organisation in a common structure. It combines design, enterprise economy and strategy, technology and internal capabilities. These factors always affect its products. The text [Hyysalo 2009] examines customisation for users by innovation. The publication [Manlig 2014] reminds of a computer aided simulation from the perspective of the process innovation.A special module for exploring the relationship of technology, prices and productivity in the organisation is represented by the authors [Byrne 2017]. The article [Chan 2001] points directly to principles of a material flow design, not only in the organisation, and develops a system of selecting a suitable device in this direction, including also artificial intelligence elements. The study [Singh 2013] describes implications of the transformation of aproduction equipment in relation to the supply chain in forward and backward planning, when the organisation faces large stockpiles. Researches about production and storage combinations are quite common. For example authors [Bertsimas 2001] represents a step-by-step model of production system that minimizes inventory costs. The unification of inventory optimisation models of the production organisation brings the article [Persona 2007] and the text [Sarkar 2013] in relation to security of supply. The article [Stock 2016] examines the Industry 4.0's relationship to equipment of the organisation. Texts [Bartosik 2017]and [Intemac 2017] describe in detail the first application of the Industry 4.0 in the Czech Republic in terms of return on investment and cooperation in the construction and description of a particular production cell where the logistics function is provided by the robot, diagnostic features are used for a maintenance and a safety point of view. The research of differences between organisations with production on a warehouse and on a turn-based basis from all angles is dealt with by articles [Olhager 2012] and [Iravani 2012]. Methods based on an evolutionary approach and genetic algorithms for cutting stock solutions are presented in the study [Levine 2004]. The dynamics of the inventory management system in relation to input inflow delays and a management delay according to the text [Yasarkan 2005] leads de facto to system instability. The existence of many hundreds of nonconformities in loading and storage, documentation and employees is presented and their removal is dealt with in the article [Zetes 2017]. According to authors [Chromy 2017a], the powerful rack stacker is deployed in the organisation in a limited space according to the pull storage principle. Similarly to previous texts, the author [Zavesky 2017] takes the issue and adds a factor in the logistics, which is shown in the example of the autonomous robotic car in the rack warehouse. The lack of storage space is also solved by the article [Chromy 2017b].
A modular architecture and an interconnection for other stakeholders and the involvement of visionaries are recommendedto solve by the article [Gawer 2014]. It perceives the matter as long-term. The text [Hyysalo 2009] recommends so-called Microinnovation, which includes analysis of the composition of the equipment, everyday life of workplaces, changes in procedures, and trying to involve users. According to the article [Chan 2001] it is crucial in the organisation a storage and a material handling equipment. The model of authors [Bertsimas 2001] conforms to the demand and also to the service department. The article [Stock 2016] highlights the importance of sustainability and respect for social aspects in relation to the equipment of the organisation and the Industry 4.0. According to the article [Olhager 2012], the interconnection of suppliers has an impact on the productivity of the organisation in custom-made production. The exploring of relationships between demand, production capacity, cost and productivity is the topic of the article [Iravani 2012]. The text [Sarkar 2013] takes into account of characters of reliability, safety supplies and production constraints. Inventory and trays in relation to post-disaster and preventive maintenance include the proposed model, where it is the resulting in a cost reduction. The study [Levine 2004] addresses the issue of stock and packing using an ant colony analogy. According to the text [Yasarkan 2005], it is necessary to consider the delay of the information flow in relation to the material flow control and to derive inventory control from that. The article [Zetes 2017] uses an automated solution to track nonconformities, tracking labels and a number of pallets, capturing them, automatically moving them

over conveyors and storing them. In addition to manipulation and storage technology, cameras, 2D, line and RFID codes, hands free sets, data storage and so on are a part of the storage system. The advantage of the solution according to the author [Zavesky 2017] is the decentralisation and the un-need ofan additional equipment and the security for totally random people. An acoustic and a visual signalling and an emergency button are preserved here.

A common problem for many managers, for example according to the article [Gawer 2014], is the joint management of all industrial platforms (networks, structures, technologies) and related systems. In addition, economic publications have all technologies already in use and do not perceive their development. Another problem for organisations is the orchestration. The position of microinnovative users is a weaker against commercial solution suppliers according to the text [Hyysalo 2009]. The article [Chan 2001] points to a lack of tools to help with a particular choice of storage and handling equipment (warehousing and handling equipment). According to authors [Bertsimas 2001], modern complex manufacturing systems are rather flawed. The situation is seen strictly by the article [Persona 2007] when it says that organizations often make and buy parts before getting orders. Inventory security is also a prerequisite. From the determination of whether or not the organisation is oriented to production in a warehouse or not, tasks of improving of the supply chain are emerging. The problem is in dynamic inventory management and current management, as the text [Yasarkan 2005] points out. The problem with the status quo, location, and safety of stored parts are described by articles [Chromy 2017a]and [Zetes 2017]. The article [Chromy 2017b] also points to the need to persuade employees that their new storage and logistics equipment will make it easier for them to work. Rather than the problem, the text [Intimacy 2017] quotes offers a way to re-establishof cell functions with the Industry 4.0 context.

The publication [Gawker 2014] recommends exploring interface roles and developing specific technologies. The study [Levine 2004] recommends the examining of different classes of packaging and supply problems in connection with sophisticated tools. There is also a need to advance the stabilisation of inventory management systems in organisations, for example by text [Yasarkan 2005]. According to the author [Chromy 2017a], it is necessary to count a loading time and an equipment programming time, which is not yet the case. Texts [Bartosik 2017] and [Intemac 2017] recommend all Industry 4.0 applications that support storage devices as well.

3 DISCUSSION ON THIS TOPIC

The whole range of storage issues is dealt with in above mentioned publications. However, the core of the modern storage equipment in the context of current challenges is somewhat lagging behind. The production of the organisation on the warehouse, not for customers, can still be meet. Producers' unadvanteges to inventory correspond to findings that correlate with the absence of the process approach in organisations such as the book [Pelantova 2014].The guaranteeing of probability of storage according to the text [Bertsimas 2001] appears to be contradictory in current market conditions. From a safety point of view, again this is a real matter. Storage and logistics safety is starting to play and is a new topic.

The author [Zavesky 2017] describes one of the most sophisticated and logical storage algorithms in the author's opinion. Simultaneously, the solution with the common ´traffic rules´ is more understandable to most people than complicated artificial rules of some programmers. Zaveskýs solution could mean a great extension of this application among organisations. The deletion of the intermediate store and the restriction of an additional infrastructure in the warehouse,as it is written by texts [Chromy 2017a] and [Zavesky 2017], are both by procedural and economical advantage. It responds to new trends. In particular, it reduces the production time and saves a space. Also, Kaizen's involvement in storage can be highly appreciated. Articles such as [Chromy 2017b] and [Zavesky 2017] also agree to minimize space and do not need large rebuilds when a new warehouse is built. Well, these facts correspond to requirements of the revised the ISO 9001 standard [ISO 9001]. The sourcing of logistics solution by analogy with ants can be considered as methodologically revolutionary and consistent with the required sustainability.

The literary research is based on the need to separate man from the storage system as an error component, which corresponds with the article [Zetes 2017]. The analysis of nonconformities in an organisation's system as a tool proved to be simple in this solution, enabling many nonconformities to be detected outside of originally considered area of organisations. In addition, a modern diagnostics make it easier to track the product throughout the production and supply chain. Savings associated with storage equipment significantly save space, time, and weighing of warehouse items. From available publications on types of warehousing and logistics equipment used, there is a predominance of shelves and stackers. Autonomous cars are a very popular, which just by their safety surpass the human driver. The consideration of the maintenance of a storage equipment as in the text [Sarkar 2013] should be considered as the basis for a subsequent operability and hence the fundamental aspect of de facto productivity of the whole organisation. The issue of the information flow delay, for example according to the text [Yasarkan 2005], is a logical from a physical point of view, but it is an incomprehensible for a part of top managers, causing considerable complications throughout organisations. Again, there is a need to emphasize that the limits imposed by the nature, whether it is spreading the message, the loadbearing capacity of materials and so on. They just do not go beyond it and have to be taken into storage and logistics planning as it is.

It should also be noted that the training of staff for the Industry 4.0 is rather a regional matter according to the literary research above, even in relation to the storage equipment. However, from publications presented here, it is more likely to be satisfied with benefits of the Industry 4.0 than the existence of some nonconformities. The expanding of function in the text [Intemac 2017] can be seen as a challenge for the deployment and further development of storage systems for the Industry 4.0 concept. The article [Stock 2016] points to the sustainability and social aspects in relation not only to organisation's warehouse equipment and to the Industry 4.0. It is not just about economic characters, as it is commonplace. Such a solution can already be considered complex. Due to the complexity and in a certain direction of inertia in the storage, however, applicants will wait a while for such applications.

Paying attention to the way management and storage is definitely worthwhile. However, this is significantly influenced by the internal context of the organisation. Furthermore, this factor is quite influences the mentioned productivity of the organisation as a whole. It can be said that it is a more important than the strengthening of standards, even though it is happening in some organisations. The gradual alignment of

links in the organisation leads to the construction of socalled orchestration. Tools and storage equipment is not so much thematically specifically discussed. It is limited, for example in the Czech Republic, rather to the domain of advertising. The choice of storage equipment therefore remains with employees. From the point of view of the development of storage equipment, there is a need for suitable characters that are needed to measure targets in a complex warehouse management. It also affects the instability of organisations. Thisarticle aims to map the situation in the area and to make some recommendations.

4 PILOT PROJECT

This article introduces a pilot project to examine the status quo of storage equipment in selected organisations in the Czech Republic. There were randomly selected 7 organisations, 5 small and medium-sized organisations and 2 large organisations. The industry is represented by automotive, mechanical engineering, electrotechnical engineering, food and service organisations. Depending on the type of production, these are organisations: 3 with a piece production, 3 with a small-volume production and 2 with a large-volume production. Legal entities are limited liability companies and joint stock companies. Organisations have organisational structures, ranging from team to functional. All organisations have a well-established quality management system and some have other management systems in place. Respondents were technicians of these organisations.

Due to the need for this study, the status quo of the warehouse equipment of these organisations is further analysed in the following. Based on literary research, according to the knowledge of corporate practice of article authors and according to the analysis of a common market offer with storage equipment in the Czech Republic, the research was based on the following palette of characters. These include following charactersand also evaluation range: storage nonconformities (the list of found nonconformities), the existence of a smart warehouse (yes, half, no), the main equipment of the warehouse (the list of a basic equipment), written or electronic documentation, whether stock optimisation is used (yes, half, no), the size of area of the stock (small, medium, big), the existence of an intermediate storage (yes, half, no), the using of system improving of storage (yes, no), the principle of storing push or pull, the connection with the production (what is being done), informing employees (yes, half, no), old equipment (old, newer, modern).

A common market offer in warehouse equipment for organisations in the Czech Republic, even taking into account the list of devices in the book [Legat 2013], mainly offers following items: boxes of all sizes and special KLT boxes, containers, crates, racks, handling equipment - wheelchair, walkie truck, chassis, lifting table, ladder, stairs, mobile platforms, wheels, cages, strippers, cantilever racks, cabinets, cranes, cleaning stations and so on. It includes not only storage and handling equipment, but also labelling, weighing, measuring, securing, next packing and so on.

In view of these findings, the current status quo of warehouse management by selected organisations was assessedby common statistics methods. The results are as follows: The smart warehouse is used in 28.6% of the organisations surveyed, the smart warehouse is used only partly in 28.6% of cases and 42.9% does not use it all. Electronic warehouse documentation prevails at 57.1%, while other organisations have a combination of written and electronic documentation in 42.9% of cases. A storage optimisation takes place at 42.9%; then, in 42.9% of cases the optimisation is halved, and in 14.3% of cases it is not. The area of warehouses is a large with regard to the area of the organisation at 57.1%, an average storage area is in 28.6% of cases and a small area is in 14.3%. Intermediate stores exist in 42.9% of cases in full, in 28.6% of cases in a part and in the same number of cases they are not used.A systemic storage improvement takes place in 57.1% of organisations and does not take place in 42.9% of organisations. The principle of push storage has 42.9% and the pulling principle has 57.1% of organisations. The linking to ownproduction takes place in organisations as follows. Approximately 28.6% of cases use directly crane, the conveyor belt and the driven trolley are used in 28.6% of cases, the combination of manual transmission of materials and a small mechanical trolley is used in 42.9% of cases. Employees are informed in 14.3% of the organisation fully, in 57.1% of organisations partially and in 28.6% of organisations are not nearly informed.

An organisational warehouse equipment looks like this. All storages of the organisation have shelves. The walkie truck uses 85.7% of organisations as a handling equipment. Additionally, 71.4% of organisations have storage facilities, a trolley, a ladder, a ladder, chassis and strippers. Even 57.1% of organisations use crates, cranes, cleaning stations and so on. So-called special KLT boxes are relatively popular in the Czech Republic and they are used by 57.1% of organisations. On the contrary, the least numerous in terms of storage equipment are cantilever racks, lifting tables and mobile platforms. It should be noted that, for example in the case of mobile platforms, this is basically a technical novelty, which is a quite expensive. The age of warehouse equipment is evaluated in organisations in 42.9% of cases as a modern, in 42.9% of cases as a newer and in 14.3% of cases as an obsolete.

Nonconformities are a special item among characters of warehouse management. They are not so much mentioned in organisations. Therefore, they are a part of a self-contained chapter.

5 NONCONFORMITIES

Following nonconformities were identified in surveyed organisations by methodobservations and by additional questions: 57.1% of organisations have surplus stocks and material exchange, 42.9% of the non-use of materials in the warehouse, non-assurance of diversification of suppliers of materials and components, disagree with the stock status physically with SW status, careless handling, 28,6% of organisations havea lack of time to receive of the material in the organisation, the neglect of warehousing maintenance, a small warehouse capacity, an inappropriate access of employees to warehouse items, 14,3% of organisations have non-identification of materials. In this study there was no a case of inappropriate storage conditions in terms of temperature, humidity, pressure, dust, biological contamination and so on, with which authors met with organisations in other studies previously.

Consequences of these nonconformities are evident in the production of these organisations as well as in the supply chain. It therefore has an internal and an external systemic context.

By analysing the types of risksaccording to the original methodology of one of authors of this article and taking into account the publication [Kamenicky 2013], external technical and economic risks prevailed. However, the socio-political risks appear to be the most serious impact on the organisation's own production. Here main human errors are shown, which can then chain other risks in the organisation. It is also necessary to consider a new role of storage due to

external factors such as: raw materials crisis, changes in the political order of the world, natural disasters and so on.

The using of Pareto's analysis tool, a significant minority of nonconformities is: stock redundancy, substitution of materials, non-use of materials in the warehouse, non-assurance of diversification of suppliers of materials and components, disagreement of the warehouse status physically with the state of SW, damage to stockpile by careless manipulation and inappropriate access of employees to warehouse items. It has to pay due attention in recommendations of preventive and corrective actions. The last item in this enumeration was determined by tool the Triangle table, because the frequency of 3 other nonconformities was also 2. The interesting thing is that the next position was the nonconformity of the neglect of maintenance of the warehouse equipment, which in general often causes problems even in large and otherwise successful organisations. By contrast, the nonconformity of a small capacity of the warehouse is now paradoxically given the most time in practical studies, as evidenced by the literary research above.

However, consequences of these nonconformities on organisations need to be perceived as well. Surplus stocks fix space, money and often also care for them. The failure to use the materials and components in the warehouse means an increase in storage costs. The non-provision of diversification of suppliers of materials and components is an external threat to organisations. The failure of one vendor may come to the organisation as a result of the entry that is needed for production. At least a delay will occur. The exchange of materials or components is a critical nonconformity in terms of risk analysis. It usually means a function deterioration or a complete malfunction. It can, however, lead to safety incidents. If the physical state of the warehouse does not match the state of SW, it is a timed problem, because it does not have to happen at first. Eventually it may mean the stopping of production. The damage to stockpiles by a careless manipulation can compromise the delivery term of supply of products, as it usually means the sudden need of materials or components. An inappropriate access of employees to warehouse items always results in damage.

6 FINDINGS

The overall evaluation of all of above-mentioned characters for each organisation by the scale indicated by these characters by authors of this article is shown in Figure 1. The second column in some organisations means the level of the process approach in the organisation with respect to other known knowledge (determined by own created the methodology of one from authors).

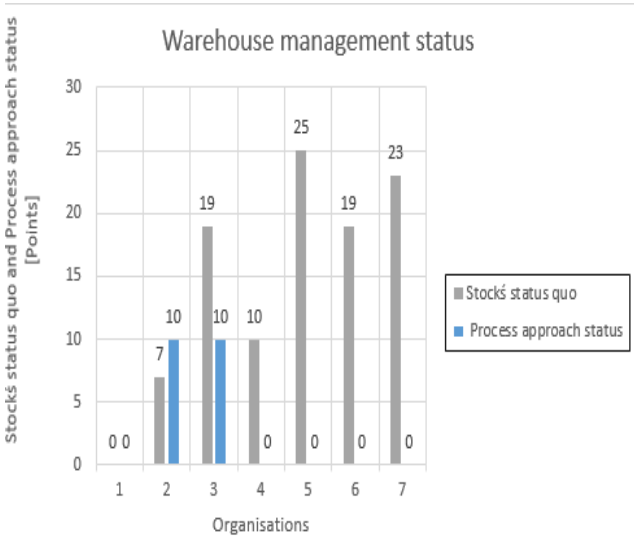

Figure 1. A warehouse management status in organisations.

By combining two characters of inventory management (the smart warehouse and the electronic warehouse documentation), can be get a good picture of ongoing automation and basically information on the progressive involvement of organisations' warehouses in the Industry 4.0. It can be said that only 2 organisations respond to the requirements of the new concept. The status quo of the existence of buffer mark is well in line with other author's studies in this article, the status quo of organisation's management system. The neglected management system corresponds to the problem of existence of buffer. The result of systemic improvement rather corresponds to managerial desires for the chosen system than the reality. Therefore, these two characters were also chosen to show the first state of affairs. The inventory optimisation matches the size of the organisation and its financial capabilities. Organisations tend to increase their warehouse space again to ensure smooth supply relationships, as the entire supply system is still burdened with a great deal of waste. Another reason has begun to be the safety impact of a globalisation of instability, where on the basis of various events, domestic organisations have been able to convince themselves of consequences of material and component supply outages. Meanwhile, the absence of an existence of buffer is a good sign for the process approach. The principle of storage should be the pull for organisations. However, some, otherwise quite advanced, small and medium-sized organisations still use the principle of push storage, which inhibits their development. Furthermore, a smaller organisation and the piece production bring an easier way to connect the warehouse to the production itself. Traditionally bad is unfortunately in organisations across the spectrum the status quo of informing of employees. The impact on storage issues can also be traced here. Employees' interest in and access to stored items is diminishing, as nonconformities present that have been identified. The damage to stock items by manipulation arises through inattention, inactivity or inappropriateness of the employee. The inappropriate access of the warehousestaff is related to the previous nonconformity. This is actually the key cause of most other problems in the organisation's warehouse economy. It is not only about wage conditions or automation warehouse equipment. It is due to the internal responsibility of anemployee who either has a birth or needs to learn it. The physical status quo of the storagemust to agree with its status in the SW. Entries should be unambiguous, regular. Electronic

registrations make this possible. To avoid nonconformities, the care must be taken to ensure that the input data are correct and well entered. The exchange of materials or components calls for innovation in the Poka-Yoke area, employee training and avoiding erroneous or incomplete identification of stock items. It does not evade small and medium or large organisations. It is manifested in small series and series productions. Paradoxically, it cannot prevent either the introduction of de facto smart warehouse or the use of electronic documentation. As a rule, however, the human factor cases somewhere along the supply chain, although the store was all right. With respect to the observations made, it can be stated that the diagnostics in the warehouse economy is applied oddly slower than in the production. In doing so, it would eliminate many nonconformities committed by organisation's employees.

In this study, on the basis of analyses carried out, it appears that innovations in the field of warehousing are being promoted slowly. In the warehouse they come as a branch of improving the status quo of their own production. The warehouse management is a by-product, albeit a complex one.A general complex of storage system in the organisation is in Figure 2.

For the reader of this article, the following steps can be recommended to upgrade of the warehouse management:

- Qualified staff is needed.
- Employee thoroughness is needed.
- It is necessary to keep the data correct.
- There is a need to strengthen the logistics maintenance competencies and to ensure a greater reliability of the warehouse equipment.
- It is necessary to optimize inventories in relation to external risks.
- Supplier relationships should be more reliable.
- The Industry 4.0 concepts can be used, where the diagnostics should be used to identify items and engage with the organisation's SW management, and the warehouse equipment should be safe and appropriate to warehouse items by type and scope.

7 CONCLUSION

This article brings a comparison of the status quo of the warehouse management in selected organisations in the Czech Republic. The Industry 4.0 characters are more applicable to only 2 large organisations. This corresponds with used diagnostics to identify items in the content, storage locations, corresponding weight, dimensions, storage and consumption dates, storage conditions monitoring and so on. The most widespread diagnostics is used to identify items in content by means of labels and barcodes. Problems are with damaged labels on stock items. Diagnostics, however, has not yet been fully developed in most of organisations. There are many nonconformities in stock economy of organisations. Surplus stocks that stem from an unbalanced production system and the disorder of item's depreciation and the attribution of their delivered supplies are crucial. This puts demands on heavy loading of used racks or crates. The second major nonconformity is the exchange of stock items (materials or components). This is a risk of nonconformity with regard to the safety of persons and maintenance of the functionality of the product. In general, safety reasons for storage are becoming increasingly important due to the need to prevent inappropriate manipulation of items of all kinds by unauthorized persons. In this case, it comes back to a more sophisticated diagnostics. Further suitable storage equipment is needed. Its modernisation in this monitored sample of organisations is progressing slowly. Robotic systems are used only in one warehouse case. So far, a human work in the warehouse, which is supported by small manipulation techniques, prevails. Mechanical platforms and autonomous conveyors are not expanded to facilitate work. The main obstacle to the development of warehouse automation is, according to this survey, the high cost of such equipment. The major factor influencing the work of warehouses is the human. Due to his lack of interest and reduced internal responsibility (not recorded in the organisation's documentation), he or she introduces errors in the storage information system and inappropriately uses and inadequately maintains a storage equipment. This creates secondary nonconformities.

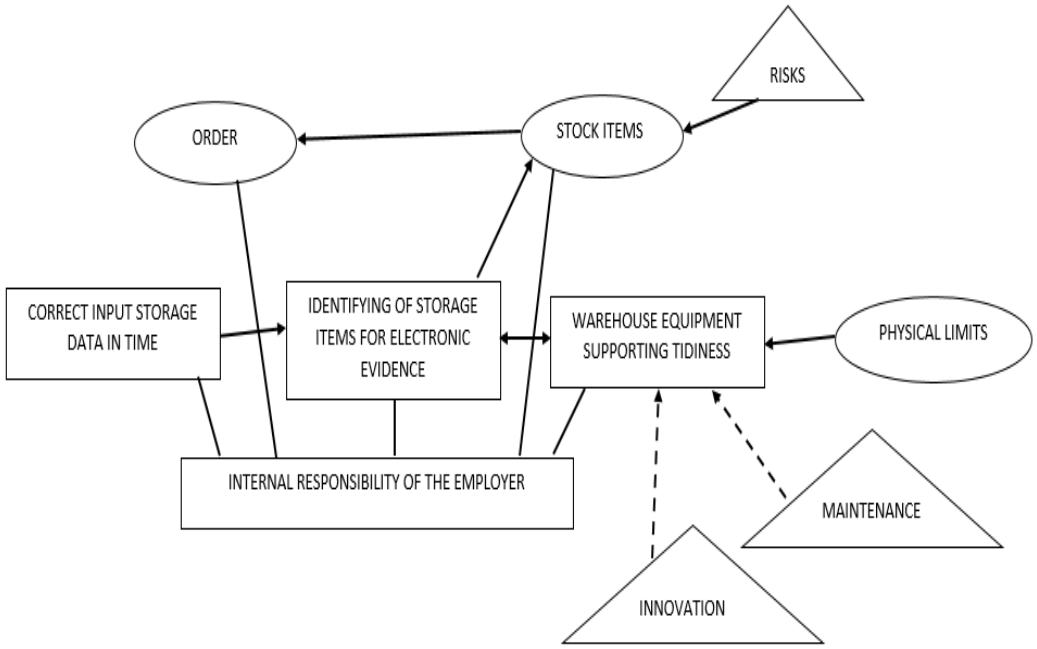

Figure 2. A general complex of storage system in the organisation.

The maintenance after defaults is prevalent, often it is a quite incompetent. Also the system management of warehouse management would deserve a more real attention. This survey shows that there is no link between the current use of Industry 4.0 elements in warehouse management by organisations and their status quo of the process approach in the management system. It should be remembered that the quality and speed of its production depends on the organisation's warehouse economy, including equipment.

This contribution is limited by a limited sample of organisations and regional specialties of warehouse management, and in relation to the warehouse equipment.

Therefore, further exploration in this area will continue with this pilot example. For further surveys, it is advisable to expand the sample of organisations. The interesting matter would be an international comparison of warehouse specialties. It is possible to focus on selected industrial fields and a related storage. A particular attention would be paid to exploring industry standards of the warehouse management. Of course, there is need to further explore possibilities of deploying the Industry 4.0 in warehouses in connection with human factor and society.

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CONTACTS:

Ing. Vera Pelantova, Ph.D.
Technical university of Liberec
Faculty of Mechatronics, Informatics and Interdisciplinary Studies, MTI
Studentska 2, 461 17, Liberec 1, Czech Republic
Tel.: +420 485 353 520, vera.pelantova@tul.cz
www.tul.cz

Ing. Eva Sirova, Ph.D.
Technical university of Liberec
Faculty of Economics, KPE
Studentska 2, 461 17, Liberec 1, Czech Republic
Tel.: +420 485 352 353, eva.slaichova@tul.cz
www.tul.cz