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INFORMATION SYSTEMS IN DIGITAL INDUSTRIAL ENTERPRISES

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Filip Praj[1] – *orcid id: 0000-0003-2303-5532, e-mail: filip.praj@stuba.sk*
Vanessa Prajová[1] – *orcid id: 0000-0002-1260-4675, e-mail: vanessa.prajova@stuba.sk*
Katarína Lestyánszka Škůrková[1] – *orcid id: 0000-0003-0088-5454, e-mail: katarina.skurkova@stuba.sk*
[1]Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Institute of Industrial Engineering and Management, **Slovakia**

Abstract: Industry leaders, together with their horizontal value chain partners, digitise the core functions of their internal (vertical) operational processes. They are strengthening their product portfolio with digital functionalities and introducing innovative data services. More than 2,000 companies expect a significant increase in the overall level of digitisation. Although only 33% of them rate their company's current state in this area as advanced, by 2020, this percentage is expected to rise to more than 70%. At the end of this transformation process, successful industrial companies will become true digital enterprises, which will have at their core physical products augmented by digital interfaces and innovative services based on the active use of data. These digital enterprises will work together with their customers as well as suppliers in industrial digital ecosystems. These developments will not only fundamentally change individual companies, but also transforms market dynamics across a range of industries. And this is true in countries all over the world - as both developed and emerging markets. In order to generate additional revenue, the companies will bring new industrial products to the market equipped with digital features and expand their existing portfolio. Digital-based services based on data analytics as well as complete digital solutions serving customers, will be the main will be the main drivers of revenue growth. The biggest challenge for industrial for industry leaders is not technology, but people. While digital technologies are fast becoming a commodity, the success largely depends on the digital IQ of an organization, especially on how its executives (CEO, CTO, or CIO) can drive this transformation can define, communicate and manage it. To develop digital processes and services is necessary sufficient qualification of key staff. The introduction of each significant change in the enterprise is is accompanied by a challenging transition period, so that the ability to manage and to manage such change will have critical. It will be important also increasing skills in data analytics and improving the organisational structure
Keywords: information systems, production quality, digitalisation

1. INTRODUCTION

Along with the economic growth of the company, its size and organisational structure is growing, specific functions and specialised departments are being created. The approach of one complex information system is basically impossible and it is necessary to specify and adapt the information systems to specific departments with the necessary functionality with an appeal to maintain the possibility of mutual communication of these IS. Information systems can be divided according to a number of criteria.

The division of IS in terms of form of use (Baglieri et al., 2014):

- Enterprise information systems, IS in the corporate environment.
- Public information systems, TV, radio.
- Government information systems, IS in a public administration environment.
- Personal information systems, personal IS of individuals.

The division of the IS of the enterprise from the perspective of production and sales (Baglieri et al., 2014):

- ERP - Enterprise Resource Planning - integrated IS, represents the core of the enterprise information system, includes the integration of production, logistics, finance and human resource management departments.
- SCM - Supply Chain Management - information system for supply chain management.
- CRM - Customer Relationship Management - information system for customer relationship management.
- MIS - Management Information System.

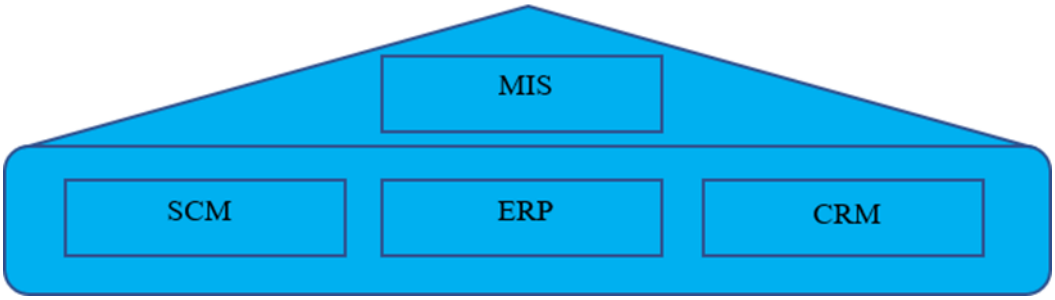


Fig. 1. The IS pyramid (Baglieri et al., 2014)

A classification of enterprise information systems (Baglieri et al., 2014):

- Operational management, streamlining day-to-day operations.
- Tactical management, processes semi-structured data and includes management information systems.
- Strategic management, decision support system and management support system.

Implementation and life cycle of information systems

Implementing IS into the core of a company is a complex process requiring human capital, financial resources and the essentials of project management. The implementation of such systems must be in the hands of sufficiently qualified experts with the cooperation of the organisation that specifies the system requirements. Such implementation will result in a functional IS that meets the requirements and desired functionality of the organisation. Thus, the basic step in IS implementation is the formation of a project team. The team

should be built in such a way that all the requirements of an effective team are met and that all the competencies of the team roles are present in the team. The formation of the team depends on the IS implementation procedure chosen, where the team may consist of purely internal company employees, company employees and external experts or purely external resources and hence complete outsourcing of the implementation. The most ideal way, if the company does not have sufficient IT background, is the formation of a team consisting of internal employees and external experts. Where the experience and knowledge of IS implementation along with the knowledge and requirements of the organization complement each other (Perna, Baraldi, 2014).
The implementation of a new IS in an organization can be done using 4 implementation strategies, which depend on the size of the company, the state of IT and the literacy of its users. The following strategies are known (Bruckner, Buchaltseva, and Voříšek, 2012):
1. Concurrent strategy.
In operational terms, the old IS system remains in place and the new one is implemented in parallel.
2. Pilot strategy.
The whole product is introduced at once. It starts with one department, one section. In this phase, it is tested and users are familiarized with the system. Then, after experience is gained, errors are eliminated and employees are trained, the IS is rolled out to the entire organization.
3. Sequential strategy.
Time-consuming, need for good planning arises, is implemented department by department. Suitable for companies where departments are not too interdependent.
4. Impact strategy.
The riskiest of the above. It is suitable where there is no other option and a strong need for a new IS. Also suitable for companies with demanding needs for computer capacity or network load.
In the context of the diversity and fragmentation of organisations, we cannot talk about the right or appropriate strategy and its choice is individual to the specific requirements of the business. Each of the strategies mentioned above has its advantages and disadvantages and in some cases organisations resort to a combination of several strategies.

2. METHODOLOGY OF RESEARCH

The HOS8 questionnaire is an analytical method for evaluating an information system. It is processed before the actual implementation of the IS, and the result of this analysis is a report on the IS balance and summary status. This method of IS DRM analysis was chosen because it can provide summary information on the status of both the implemented IS and the already implemented IS and can provide valuable data for further development. A total of 8 investigated areas are evaluated, which are hardware, software, orgware, peopleware, dataware, customers, suppliers and IS management.
In the framework of the IS DRM analysis methodology, the importance of this IS for the company was determined to be v = 0 out of the possible values -1, 0 and 1, where v = the importance of the IS for the company. This value indicates that the IS under study is important to the operation of the company but its short-term failure will not significantly affect its operation or profitability or customer satisfaction. Subsequently, the questionnaire was answered by the competent persons in the company and the

investigated areas were rated on the basis of a conversion table. This resulted in an average rating for each area ranging from 1 to 5, a description of the resulting scores achieved for the areas examined is available in Table 1. The questionnaire was processed on segment B/P21. Segment B/P21 is one of the segments producing for the automotive market. Its main customers include Getrag, Seat, Daimler, Volkswagen, Skoda, ZF, Ford and SKF. The segment's main products include needle roller bearings. The segment has a range of technologies from turning, drilling, heat treatment to grinding height, surface and bore, honing and subsequent assembly with packaging. Thus, most parts belonging to the segment spend their entire transformation process only on this segment, with the exception of some technological operations that are covered by internal or external cooperations.

Table 1
Significance of the values of the HOS 8 domains investigated

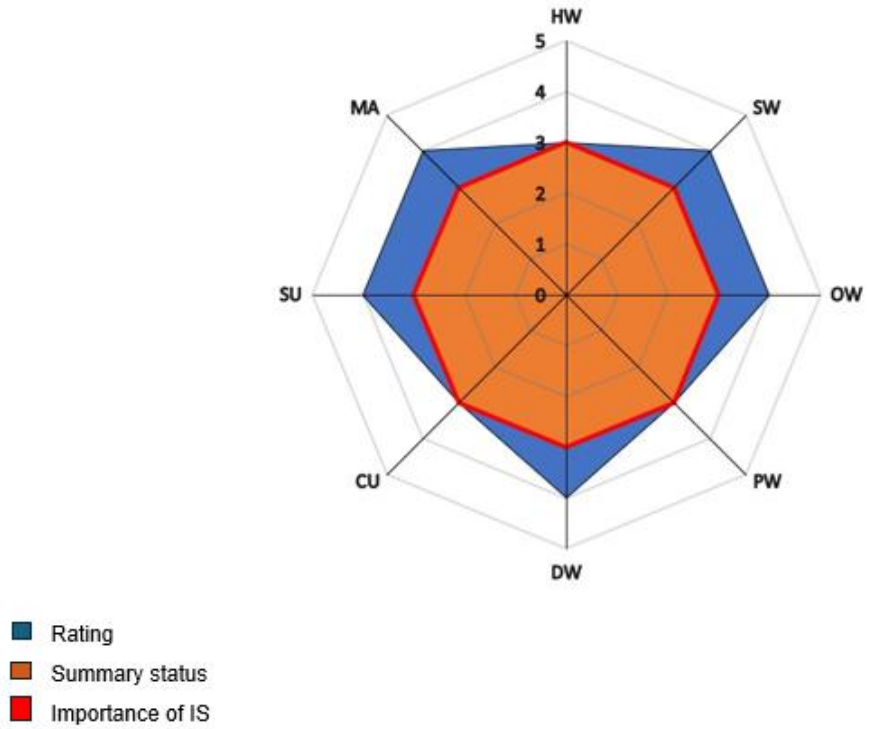
Nominal value - ui	Status of study areas
5	Very high level of the study area
4	High level of the study area
3	Middle level of the study area
2	Low level of the study area
1	Very low level of the study area

An evaluation of the questionnaire and all its surveyed areas is presented in Table 2.

Table 2
Evaluation of the HOS 8 questionnaire domains

Area	Shortcut	Rating
Hardware	HW	3
Software	SW	4
Orgware	OW	4
Peopleware	PW	3
Dataware	DW	4
Customers	CU	3
Suppliers	SU	4
IS management	MA	4

Based on the results of the analysis, the ***aggregate status of the DRM IS*** is 3, referring to Table 1, this is a medium level of IS. The medium IS level is satisfactory for an IS with normal importance and its importance v = 0. A higher aggregate status level could indicate inefficient spending. Based on the HOS 8 analysis, the balance of the examined IS was also found. There are only 2 adjacent values of 3 and 4 in the studied areas, and one of them, 4, prevails. ***The DRM IS is therefore balanced***. A graphical representation of the evaluation of the HOS 8 analysis is shown in Graph 1.



Graph 1. Graphical representation of the evaluation of IS DRM analysis by the HOS 8 method

3. RESULTS

On the basis of the processed analysis of the DRM information system in the industrial enterprise XYZ by the method of the HOS 8 questionnaire, own observations and the identified shortcomings and imperfections, 3 solutions were proposed to optimize and extend the functionality of this IS:

1. Optimization of the process of training of IS DRM users in an industrial enterprise

Based on the evaluation of the HOS 8 questionnaire and its results in the investigated areas PW and CU, it is proposed to optimize the process of training IS DRM users in the industrial enterprise XYZ. by dividing the training process into 5 stages and changing the methodology of the training itself.

Stage 1 - preparatory stage.

In the pre-implementation phase, hold a kick-off meeting with the department where the IS is to be implemented. It is necessary to familiarize both parties with the initial information and define the requirements and conditions. This stage also includes the preparation of the actual training in the form of HW, SW, system treatment, granting permissions to new users or even the treatment of the production contract required for the training.

Stage 2 - the training itself.

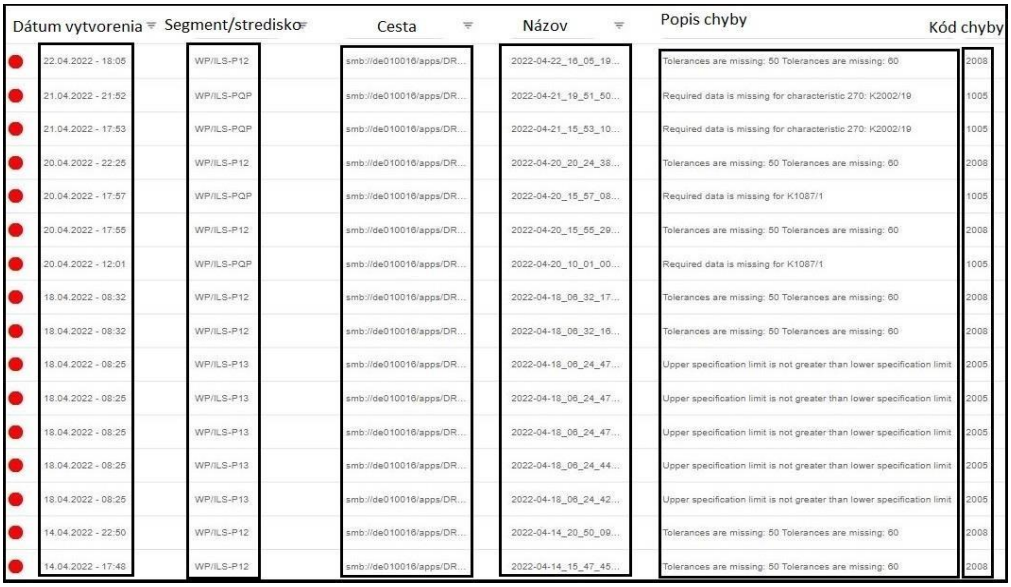
The actual training will take place directly in the production during the morning shift at specific centres of new users of IS DRM. Such production is equipped with IPC, industrial personal computers. Thus, the training will take place virtually on a specific machine in the production, where the employees will be the ones operating the IPC with the DRM information system active, assisted by the trainer. They will thus have the opportunity to test the information system immediately and to react to its operation or to be active during the training.

Stage 3 - taxiing.
During this stage, the information and knowledge gained is rolled and sold between work shifts. The selling of information takes place with the assistance of competent persons, and it is possible to contact the persons responsible for the implementation of DRM at any time to consult discrepancies. If necessary, an individual or group training session will be arranged for the 2nd or 3rd shift, respectively, one week after their rotation.
Stage 4 - assessment and resolution of critical situations.
In Stage 4, the training conducted is evaluated and commented on. They are evaluated by new users of IS DRM, who, in addition to the possibility of evaluating and commenting on the training itself, also have the opportunity to comment on the IS DRM itself with the passage of time since the training. Stage 4 is also intended for solving critical situations that occurred during the training, e.g. for certain reasons the staff was not trained, HW, SW not working, long-term sick leave, etc.
Stage 5 - Process setup and continuous improvement.
Based on the evaluation of the training process developed in Stage 4, measures will be set. It will be determined whether training needs to be repeated or whether training needs to be set at a certain annual frequency. At this stage, measures are also set for the comments received during the training process and also measures for critical situations that may have arisen during the process, thus leading to continuous improvement.
Throughout the training period as well as after its processing, staff responsible for the implementation of the IS DRM are available. In addition to the actual training of new users, they also act as support for processes and operations in the field of IS DRM from the production, users and their requirements.

2. Optimization of system data processing in IS DRM by extending the IS functionality with import log.

The initial kick-off meeting prior to the actual implementation of the IS DRM will include in its start-up plan points that deal with the solution of the system data treatment between the IS DRM and SAP, namely the definition of tasks and those responsible for their execution. Responsibility for data treatment in SAP lies with the relevant industrial engineer of the relevant segment, and in the context of data digitisation, this is done in coordination with the Digital Enterprise department. We consider it necessary to continue to meet on a minimum 2-weekly basis to present results, executions or newly arising deviations to each other.
In case untreated data remain in the system, it is proposed to extend the functionality of this IS by importing the log of unmatched plans. There may be situations where no data and data from SAP is pulled into the DRM, or erroneous and non-compliant data and data is pulled in. In this case, the system will compare them with the prescribed values and evaluate them. It reports the error with an error message, which it then generates in the import log. The import log will be available to all IS DRM users. The import log itself will carry information that can be used to clearly identify the root cause of a system data mismatch. The identifier to unambiguously associate the problem to a given product will be the production order. In order to extend the functionality of IS DRM by importing the log, a code register was created, which can be used to clearly identify where and why the deviation occurred. Currently, 16 error codes are processed, which describe the cause of the problem and provide general instructions and options on how to solve them. In the import log it will be possible to filter the data and the responsible employee will be able to identify just those deviations that concern his/her segment or centre. Once the error

message has been processed, it will be removed from the log. The implementation of this measure is the responsibility of a team of programmers centrally responsible for the functionality of the DRM IS in Germany. A visual preview of the import log is available on the following page as Figure 2. A preview and register of the error messages and their associated codes is available on the following page as Table 3.



Dátum vytvorenia	Segment/stredisko	Cesta	Názov	Popis chyby	Kód chyby
22.04.2022 - 18:05	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-22_16_05_19...	Tolerances are missing: 50 Tolerances are missing: 60	2008
21.04.2022 - 21:52	WP/ILS-PQP	smb://de010016/apps/DR...	2022-04-21_19_51_50...	Required data is missing for characteristic 270: K2002/19	1005
21.04.2022 - 17:53	WP/ILS-PQP	smb://de010016/apps/DR...	2022-04-21_15_53_10...	Required data is missing for characteristic 270: K2002/19	1005
20.04.2022 - 22:25	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-20_20_24_38...	Tolerances are missing: 50 Tolerances are missing: 60	2008
20.04.2022 - 17:57	WP/ILS-PQP	smb://de010016/apps/DR...	2022-04-20_15_57_08...	Required data is missing for K1087/1	1005
20.04.2022 - 17:55	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-20_15_55_29...	Tolerances are missing: 50 Tolerances are missing: 60	2008
20.04.2022 - 12:01	WP/ILS-PQP	smb://de010016/apps/DR...	2022-04-20_10_01_00...	Required data is missing for K1087/1	1005
18.04.2022 - 08:32	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-18_06_32_17...	Tolerances are missing: 50 Tolerances are missing: 60	2008
18.04.2022 - 08:32	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-18_06_32_16...	Tolerances are missing: 50 Tolerances are missing: 60	2008
18.04.2022 - 08:25	WP/ILS-P13	smb://de010016/apps/DR...	2022-04-18_06_24_47...	Upper specification limit is not greater than lower specification limit	2005
18.04.2022 - 08:25	WP/ILS-P13	smb://de010016/apps/DR...	2022-04-18_06_24_47...	Upper specification limit is not greater than lower specification limit	2005
18.04.2022 - 08:25	WP/ILS-P13	smb://de010016/apps/DR...	2022-04-18_06_24_47...	Upper specification limit is not greater than lower specification limit	2005
18.04.2022 - 08:25	WP/ILS-P13	smb://de010016/apps/DR...	2022-04-18_06_24_44...	Upper specification limit is not greater than lower specification limit	2005
18.04.2022 - 08:25	WP/ILS-P13	smb://de010016/apps/DR...	2022-04-18_06_24_42...	Upper specification limit is not greater than lower specification limit	2005
14.04.2022 - 22:50	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-14_20_50_09...	Tolerances are missing: 50 Tolerances are missing: 60	2008
14.04.2022 - 17:48	WP/ILS-P12	smb://de010016/apps/DR...	2022-04-14_15_47_45...	Tolerances are missing: 50 Tolerances are missing: 60	2008

Fig. 2. Visual preview of the import log in IS DRM

Table 3
Error messages register

	Kod chyby	Popis chyb	Riesenie	Poznámka
1	2004	chyba v toleranciách - dolná tolerancia väčšia alebo rovná hornej (Upper specification limit is not greater than lower specification limit: 2 = číslo riadku)	korekcia NnK/U	DRM_Chyby.pptx
2	2005	chyba v zadaní menovitej hodnoty a tolerancií (Upper specification limit is not greater than lower specification limit: 5 = číslo riadku)	korekcia NnK/U	DRM_Chyby.pptx
3	1000	chyba v zadaní menovitej hodnoty a tolerancií (Upper specification limit is not greater than lower specification limit: 5 ; Upper tolerance is not greater than lower tolerance 5= číslo riadku)	korekcia NnK/U	DRM_Chyby.pptx
4	2012	Nie sú zadané tolerancie (Tolerances are missing 3 = číslo riadku)	korekcia NnK/U	DRM_Chyby.pptx
5	K1087 / 1005	chyba text u AVO (operácie -riadku), číslo chybného AVO je v stĺpci I . Toto AVO väčšinou doplňané priamo do zákazky s tým, že nevložia text.	u tohto AVO nie je NnK/U, príp. výr. plánu - tj. je nerelevantné pre elektronické úvoľnenie u stroja, korekcia v zákazke zmazanie tohto AVO, príp. doplnenie textu / v prípade potreby dotlačenie skupinového z ZQP06	
6	K2002 / 1005	chyba zadaný skúšobný pararameter (napr. šírka...) - je tam prázdny riadok	korekcia NnK/U	na segmente H bolo ZQ0
7	K2002 / 1000	chyba zadaný skúšobný pararameter (napr. šírka...) - je tam prázdny riadok	korekcia NnK/U	
8	K1041 / 1005	chyba číslo výkresu u daneho AVO	korekcia výkresu v NnK/U alebo výr.plán ? Kusovník FHM ?	
9	K1042 / 1005	chyba index výkresu u daneho AVO	korekcia výkresu v NnK/U alebo výr.plán ? Kusovník FHM ?	
10	K1043 / 1005	chyba typ výkresu u daneho AVO	korekcia výkresu v NnK/U alebo výr.plán ? Kusovník FHM ?	
11	K1041 / 1000	chyba číslo výkresu u daneho AVO	korekcia výkresu v NnK/U alebo výr.plán ? Kusovník FHM ?	
12	K1042 / 1000	chyba index výkresu u daneho AVO	korekcia výkresu v NnK/U alebo výr.plán ? Kusovník FHM ?	
13	K1043 / 1000	chyba typ výkresu u daneho AVO	korekcia výkresu v NnK/U alebo výr.plán ? Kusovník FHM ?	
14	K1081 / 1005	chyba číslo stroja u daného AVO	1.) korekcia výrobného plánu u daného AVO 2.) môže byť aj vložené AVO v zákazke s neúplnými údajmi - potom v prípade potreby dotlačenie skupinového z ZQP06	zodp za korekciu v pláne
15	K1082 / 1005	chyba názov stroja u daného AVO	1.) korekcia výrobného plánu u daného AVO 2.) môže byť aj vložené AVO v zákazke s neúplnými údajmi - potom v prípade potreby dotlačenie skupinového z ZQP06	zodp za korekciu v pláne
16	2008	chýbajúce tolenacie: číslo parametra	korekcia NnK/U	

3. Extension of the IS DRM functionality for the possibility of continuous release of production in batches.

The option to insert a text note and the option to insert an attachment will be added to the individual release parameters. This means that if I need to release one operation multiple times, due to multiple production batches and the ability to continue them in the production process independently, it will be possible to do so. A sample situation of the need for batch-by-batch release on a quench centre is shown in Figure 3.

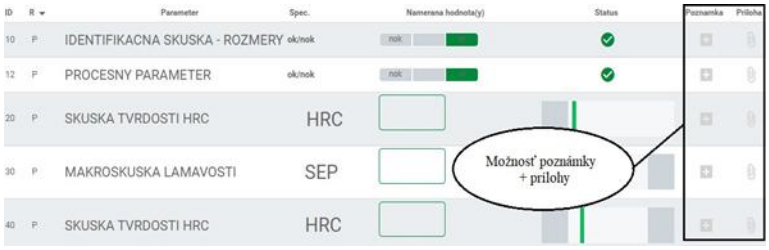


Fig. 3. Hardening release sheet and its parameters

We release the operation in the standard way, by listing the measured parameters and then releasing them, indicating in a note which dose is involved and what the measured values of the corresponding dose were. When releasing the next batch, the original release remains stored and the measured values of the second batch are written only in a note, again in the style of batch number and measured values. We continue in this way until we have released all the batches of a given production operation, of a given production order, and then close the operation. For each parameter being released it will be possible to insert attachments. The individual measured values and their logs of the released parameters for the given production batches will be inserted as attachments for their recording. This will ensure data archiving for batch-by-batch release operations. By clicking on the respective icons of the notes and attachments (see Figure 3), we can thus insert them via the newly opened dialog box. The dialog for inserting notes and attachments is shown in Figure 4.

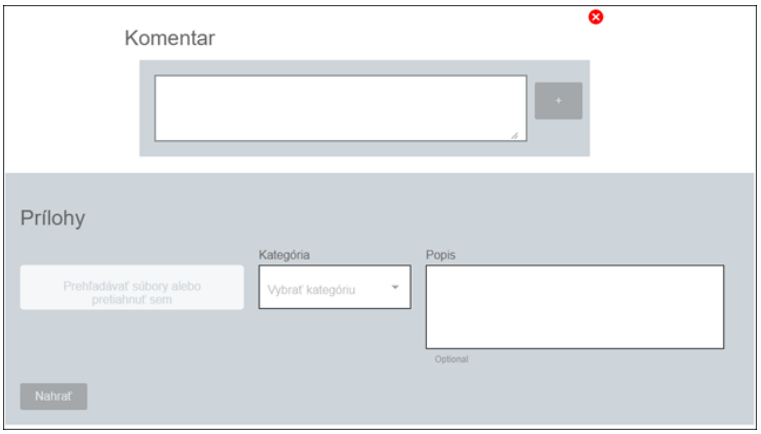


Fig. 4. Dialog for inserting notes and attachments

We suggest the possibility of adding notes and attachments to release parameters globally within all release operations in IS DRM, not only to the quenching centre, as the situation when only 1 batch of production needs to be released can also occur operationally at other centres.

4. DISCUSION

The need to implement a DRM information system arose in the context of digitisation. Digitisation itself is currently an unstoppable trend and brings many benefits, e.g. in the form of sustainability or benefits that are often of an economic nature in the form of savings. The industrial enterprise XYZ produces 75% of the production for the automotive industry and is fully aware of its product responsibility. From a quality point of view, virtually all processes are audited and regulated in some way. By implementing this IS, the

industrial enterprise replaces the inefficient and unenvironmental paper work and digitizes it into a digital form. Moreover, it brings functionalities that help to regulate, monitor and archive process data. The main enterprise IS system SAP in its production order management modules does not allow adding information on production release and from an auditing point of view cannot provide data on the quality parameters of individual production orders after the production process has been completed. This functionality is replaced by IS DRM, which also actively communicates with SAP and exchanges information. In addition, it eliminates human error in paper and manual handling of documentation. From a qualitative and especially economic point of view, the benefit of this IS lies in the fact that it does not release non-conforming production for further processing, thus eliminating waste in the production processes and avoiding the delivery of non-conforming production to the customer. On the basis of the analysis of the DRM IS directed at active users with authorisations for this IS, imperfections were identified before the implementation, during the implementation, but also during the operation of the IS itself and thus after its implementation. Based on the evaluation, only 55.83% of the respondents agree with the statement that the implementation of IS DRM made their work easier. If we rely on the evaluation in the production segment P21 after the implementation of IS, the biggest deviations are found in the training process itself and in the system treatment of data. The chosen training process by the one-shot presentation method is unsuitable for the age spectrum of users and for its information-intensive nature. Also, cumulatively, most of the own comments were on the pre-implementation phase, specifically on the system data treatment itself, which gives rise to variations in production in the form of mismatched data required for the release of production. We also find the situation at the quenching line centre, where release by production batch is not allowed, unsatisfactory from a process point of view. The analysis of IS DRM by the HOS 8 method was processed on the P21 segment. The importance of IS DRM for the company was set to the level v = 0, which represents this IS as important but not tribal for the company's operation. Based on this significance value, the IS DRM should have an aggregate status of 3, which represents a medium level of the areas under study. As a result of the HOS 8 analysis, the aggregate status of the IS was indeed set to 3, and we can also consider the DRM IS to be balanced. The lowest rating, 3, was achieved by IS DRM in the examined areas of HW, PW and CU. HW represents the physical equipment in relation to the IS and its reliability, PW represents the users of the IS in relation to the development of their capabilities, their support in using the IS and their perception of its importance, and CU, where the subject of investigation is what the IS is supposed to provide to customers and how this area is managed.

5. CONCLUSION

In the results of the HOS 8 analysis, we observe links to key imperfections in the form of inadequate training process, imperfect system treatment, and procedural inconsistencies in the IS DRM with links to just the HOS 8 HW, PW, and CU areas examined. The analysis performed on the P21 segment, where this IS is already implemented, has provided us with data from which we will apply the measures in the implementation to the other segments of the industrial enterprise XYZ. as well as data on the basis of which the optimization of the given IS will be proposed.

Inappropriate training process was one of the most frequent comments. A link to this problem was also found after the evaluation of the HOS 8 questionnaire in the PW and

CU area. Based on these findings, a measure in the form of optimizing the training process for IS DRM users was proposed to respond to the most frequent cumulative recurring comments.

Based on the results, it was found that the pre-implementation phase did not place sufficient emphasis on the system treatment of data necessary for the smooth operation of the information system itself. Consequently, there is overwork in the form of redundant rework of production plans and NnK, waste in production and in some cases a temporary need to address the situation in the form of reprinting of paper documentation. The proposed improvement emphasizes the treatment of master data for IS operation prior to actual implementation and provides a solution in the event that improperly treated data makes its way into the production processes themselves.

Based on the results of the analysis, comments from the users of the IS DRM and own observation, procedural deficiencies at the quenching centre were identified for which a measure was proposed in the form of extending the functionality of the IS DRM with the possibility of adding notes and attachments to the release parameters. In the case of batch hardening process, it is necessary to wait until the last batch is evaluated to release the operation. With the release process set up in this way, it is not possible to release and postpone production for further processing on a batch-by-batch basis, but only as a whole per production operation. By implementing this measure, we can release sequentially according to the needs and capacities of the next production operation

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