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A codification system roadmap: case study in a metalworking company

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Abstract

Decision-making and control of operational areas in industrial companies are key issues in their sustainability and resilience in markets that are more and more challenging and competitive. In this way, production management and information management software are becoming mandatory. The codification of information, namely products codification, is a subject, without being the main purpose in everyday companies' work, must be a subject that enables a proper functioning of everyday companies' activity. This project proposes a roadmap for internal product codification in a company working in the metalworking industry. This guide shows good practices that highlight formal basic rules whose could add value to internal processes of the organization and so to provide a solid system where the company can rely on providing more time to its workers to spend in other tasks. At last it is provided a generic conceptual model to serve as an approach to develop a codification system in any given organization.

Keywords: Codification; system; Roadmap; product; metalworking sector

1. Introduction

Businesses are open systems that maintain relations with third parties: customers, suppliers, banks, state and public institutions, local society, among others [1]. But even in themselves, they generate information and knowledge that, with the current increase in activity, mainly in the mechanical sector, it is urgent to be addressed [2].

Closely linked to information and knowledge, coding plays a key role in which knowledge and associated resources are gathered, stored and explicitly represented [3].

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The increasing amount of materials used in business and the increasing number of new products [4] makes this subject here exposed significantly important and therefore with the need of designing a specific coding adapted to the reality of each organization [5].

Current trends in the international economy require companies to implement innovative marketing paradigms and production, especially due to the immense variety of products, as they are current coding systems that allow the construction of easily recognizable codes and relatively short [6].

Given this scenario, this paper outputs are a codification system Roadmap resulting from a case study regarding the internal coding of products in a subcontracting market company for the metalworking industry.

The paper is organized as follows. Section 1 introduces codification, product and codification systems. Section 2 describes the concept, types, requirements, prevention and detection of codification errors. In Section 3 is introduced the case study which served as the basis for this work. Section 4 provides the codification system Roadmap. In Section 5 is given a Conceptual Model for the definition and implementation of a Codification System. Finally, in Section 6, conclusions are presented.

2. Literature review

The encoding process is described by the form in which the tacit knowledge is extracted in order to produce the encoded knowledge that binds the concept of code [13]. Several examples of coding utility are presented in different areas. Gahlod et al. [21] applied the encoding used in a State of India to develop a single national code. These authors have created an atlas comprising systematic encoding of alphanumeric form Indian basin, facilitating the management of soil and water of the Indian Government and some non-governmental organizations. To help students understand and apply methods of coding accounting systems, Lehmann and Heagy [20] have developed and used different ways of teaching which resemble the real-world experience. In the textile industry, Kumar et al. [22] introduce a new way of tracking label based in wire encoding that is fully integrated into the tissues supply chain by applying an algorithm to recognize image patterns in identification and decoding of tags. Zhu and Jiang, [15] make mention of a new hybrid coding scheme aired by the efficient representation of shape, in the shape of an object are first extracted and divided into multiple threaded segments. Are then designed and developed two modes basic encoding to encode the segments based on correlation analysis and the characteristics of threaded code, in which each chain segment is encoded with the way can produce a length of the shortest code. In the Metallurgy and metalworking, in relation to the coding of materials, you can take as an example the need to use or produce the same steel or call anywhere in the world. A company in Germany uses internally “C15” as a reference to a steel, if you want the same material in Sweden the code is "1350", or if it is the Czech Republic's the code is "12023", therefore, there is a need for a table of comparison of designations for various types of materials in the world, containing the names of materials used in England, Germany, France, Italy, Japan, Sweden and the Czech Republic. The properties and composition of the materials are not described, being limited to the names list or equivalent codes within the system of this particular country [23].

3. Codification

Since in most companies coding simplifies and significantly accelerates the product development and maintenance process [7], it is urgent to create a single language that involves classification and coding the various materials and allows to identify them in a straightforward way [8].

Nevertheless, the importance of coding in inventory management, SKU, namely the study and the analysis of the coding and reference used, plus the creation of procedures in the codification and reference of the articles, has been a marginal issue for the business community [9].

Before an adequate SKU classification, one must be aware of the number of classes used and the definition of boundaries between classes [10].

The most frequent practice currently is to define a certain number of digits that will ensure the maximum number to be controlled in the years to come. Also for that reason more and more are called code the number of stock or SKU.

The main function of a coding system is to "assign a representative code, so that it is possible to identify any article, facilitating and simplifying operations within the company" [2].

A well-structured coding and classification system should [5]:

- Facilitate the creation of families;
- Allow quick searching;
- Reduce duplicate files;
- Promote standardization of design;
- Improve cost estimation and recording.

The application of coding systems is recurrent practice in distinct types of companies and is assumed as a need. An efficient management of the inventory and business processes implies offering general logistical support [6] which involves standardization of good practice codes as a guarantee of component interchangeability and compatibility [11].

In this regard, it is necessary to argue the contribution and magnitude of the Global Standards One (GS1).

The introduction of the GS1 standards aims to improve the efficiency of registration and exchange of information throughout the value chain. The application of GS1 standards requires organizations that use them to keep track of the identification numbers (GTIN), the Serial Shipping Container Code (SSCC), and the information location codes of their GLN origin [12].

The International Organization for Standards (ISO) has also attempted to simplify and harmonize coding processes by eliminating the multiplicity of existing codes, relating to the coding process in two ways [13]:

1. They are used as a coding tool that allows the company:
   a. Formalize codified knowledge within the company (combination)
   b. Code the tacit knowledge inherent in people (outsourcing)
   c. Share experiences before the discussion about the functioning of the process (socialization)
2. The result of standardization will have to be re-appropriated by people within the company, so it can be useful and can contribute to organizational learning

As each company produces a unique and specific set of parts and products, it must design its own coding system [14], to achieve high coding efficiency [15]. It is necessary to implement prevention systems starting with avoiding confusion in the acquisition and transmission of codes, as in these examples:

- Segmented or small fields - "387 125";
- Letters "O, Q, i, I", which are confused with the numbers "0 and 1";
- Consonants that sound identically, such as "B" and "P", or "D" and "T";
- Zeros that begin fields and numbers, such as "001 099 005" [14].

If, despite prevention, errors occur, their detection is essential. Among the causes of incorrect registrations is the imprecise identification of products [16] since the task of matching product properties with product codes is extremely difficult if they are not based on the same rules [6].

One of the ways to detect this type of error is to create a key or a check digit, which regardless of the coding system, a control key must be made for each code [17]. The control digit is no more than a validation of the consistency of a code, usually present at the end of that code, which is obtained by a calculation represented in Table 1 and Table 2. Another type of error, the lack of procedures for coding and referencing, is expressed in the immense variability of product codes which should be solved by modifying the data and information entered on a given computer platform and by modifying the product families [9].

Table 1. Calculation formula of the control digit [18]

Position and number of digits					
1.º digit	2.º digit	3.º digit	4.º digit	5.º digit	Control digit
Multiply each digit by					
x1	x5	x3	x1	x3	
Add multiplications					
And subtract the result to the next multiple of 10					

Using this formula, the calculation of control digit number "6" in code "123406" is shown in table 2.

Table 2. Example of calculating the control digit of the code "123406" [18]

Position and number of digits					
1	2	3	4	0	Control digit
Multiply each digit by					
x1	x5	x3	x1	x3	
Add multiplications: (1x1)+(2x5)+(3x3)+(4x1)+(0x3)=24					
And subtract the result to the next multiple of 10: 30-24=6					

At last, a conceptual model can be suggested for the definition and implementation of a Codification System in any given organization. The definition of a Coding System should look at the classification of product families that may already be made and evidenced with an ERP / PDM / PLM, observing the following characteristics:

- Accurate and discriminatory;
- Flexible;
- Stable in time;
- Homogeneous;
- Simple.

For the organization with an Information System as an ERP / PDM / PLM, the code itself should be a non-significant one such as will be described in Section 4. For the organization, without this Information Systems, the Code should be alphanumerical. In both situations, they must follow as much as possible the rules described above.

Followed by this definition it is very important to settle a processual rule guide like a Roadmap as suggested in the chapter before to monitor the implementation and the correct use of the Codification System (Figure 1).

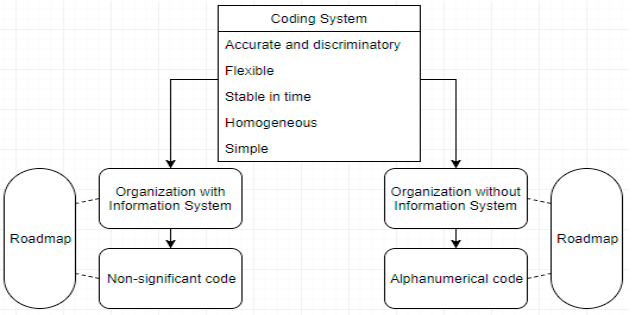

Figure 1. Conceptual Model

4. Case study

The case study involves a small Portuguese company who seeks to establish itself in the subcontracting market for the metalworking industry in Portugal.

With a monthly average cut of sheet metal over 100 tons, in recent years this company is growing and has already established several partnerships in France and Spain with companies in the automotive, agricultural, naval and construction industry, among others.

The type of production of the company under study is preferably make-to-order – a model of production processes per order in which the overall design of the product is defined, but subject to the configuration of some parts or features available. It is, therefore, a massive configuration model and it results in multiple versions and product variants.

Two different coding systems were considered – one previous and one after the implementation of the production management system, diagnosing and analysing the company's case study on this subject and underlining structure, classification and errors of the respective coding systems.

The coding structure of some of the articles before ERP implementation is composed by alphanumeric fields, separated by hyphens, without any minimum or maximum character limit, in a fully descriptive way as it can be seen in Table 3.

Table 3. Code: "ANGLE BRACKET-60X6MM-FE"

Field 1	Field 2	Field 3	Field 4
Product Line	Family	Size	Subfamily
ANGLE BRACKET	60X6MM	FE	

In particular:

- ANGLE BRACKET - It is the part of the code that indicates the product line "angle bracket", occupying the first field;
- 60X6MM - the second field of the code has the attribute "size" identifying the dimension of the angle: 60x6 mm;
- FE - Code for the "iron" family, located in the third field of the code.

With ERP implementation this coding structure had to change. The ERP is defined for numeric codes, contrary to what had been practised by the company. If previously the codes were alphanumeric codes, without any minimum or maximum character limit, in a fully descriptive way, a numerical and mixed coding system is currently implemented, thus contemplating a descriptive and non-descriptive part. All fields are numeric and separated by dots. The first three fields are descriptive, but the fourth is sequential, non-descriptive, non-meaningful, serving to differentiate codes that would be equal if there were no such field. Next, what has been previously written with this example is set forth in Table 4.

Table 4. Code: "04.200.000.0012"

Field 1	Field 2	Field 3	Field 4
Product Line	Family	Subfamily	Distinguisher
PIPE	AISI 304	Generic	
Product Line Code	Family Code	Subfamily Code	Distinguisher Code
04	200	000	0012

Since there are thirteen "PIPE" products of the "AISI 304" family with the "Generic" subfamily, for its distinction there is the fourth field. In this case, this code was the twelfth to be created so it has the suffix differentiator "0012".

A proposal for improvements to the coding system implemented with the ERP is presented below:

- Considering that the ERP in question only supports numeric characters for the articles' coding, it is suggested to move to a fully sequential 5-digit coding system starting at 1. That is, about 90000 possible codes for the future of this organization, benefiting from drastically shortening the size of the code, reducing associated errors, promoting the sustainability of the coding system without prejudice to all information associated with codes such as descriptions, product lines, families and subfamilies to be well defined so at any time using ERP to remove all the information that the organization needs;
- It is suggested to include a control code for error detection;
- Also considering the sustainability of the system and even of cost accounting, it is proposed to subdivide the "Accessories" product line which includes 247 articles, all of them belonging to the "Generic" family, and the "Bolts" "Hinges", and "Nuts" that represents about 50% of the total "Accessories" considered. The remaining "Generic" families and subfamilies should be analysed in the same way;
- For a better accuracy of the system, it is proposed to analyse and correct cases of errors of disagreement and confusion between some codes and designations. As well as to create articles referring to "FASTENINGS" that at the date of the analysis still only includes a code;

- Still associated with imprecision, reducing human errors associated with codes and referring to the traceability of the products of this organization, it would be important to make a cost-benefit analysis of the implementation of a bar code system;
- As a proposal for improvement in the rules of codification of articles that will be used from here onwards it is suggested:
  - Being defined the person in charge or a set of responsible persons who are qualified to perform this task;
  - Prepare a manual, which should be the object of consultation, whenever there is a new stock item;
  - In a presence of a new article, consult and confirm if the article is registered by searching it in ERP, in the fields "Designation", "Product line", "Family", "Subfamily" and "Remarks";
  - Create a flow of cataloguing (analysis - approval - registration);
  - In case the material does not exist in the catalogue to be codified, follow the established hierarchical structure of codification - formally defined - and pay attention to the beaconing of the software.

5. Roadmap

The roadmap with the coding system proposed for the company considers the ERP implemented, which will allow the coordination and normalization of the internal use of the defined coding system, clarifying in an unequivocal way doubts that will appear in the organization's daily routine. It will then explain the system's operation and correct procedures to ensure the codes are correctly assigned and defined.

Starting with the proposed coding structure itself in Table 5.

Table 5. Proposed coding structure

Field 1	Field 2
Sequence counter (5 digits)	Control code (1 digit)

Field 1 contains five digits beginning sequentially in digit 1, added to the control code whose calculation was explained in section 2.

Regarding articles' classification, it is proposed to maintain the base structure, i.e. "Product Line", "Family" and "Subfamily" with the following exceptions:

- Analyse and correct discordance errors;
- Create articles referring to "FASTENINGS";
- Subdivide the "Accessories" product line and "Generic" families and rename the "Generic" subfamilies;
- With this clear subject and with the new coding structure implemented, in a potential new article;
- Those who trigger this situation should search the ERP in the fields "Designation", "Product line", "Family", "Subfamily" and "Remarks" to confirm if the new article does not exist in the system;
- Communicate to the person in charge for creating articles of the new occurrence;
- And in case of approval, it should be created considering two main aspects:
  - - The ERP sequential accountability counter;
  - - The correct definition of the "Designation", "Product Line", "Family", "Subfamily" and "Observations" fields by the person responsible, considering the basic structure that is defined.

For example, consider a new "XPTO" stainless steel hinge that was purchased. After the previously defined flow, the ERP indicates the next sequential number to register the new article, for example "12340", and its control code "6" (see calculation in section 2.), for a new product code "123406". To the person in charge, it remains to be written the designation of the new article "Hinge XPTO", the product line "Accessories", family "Hinges", and sub-family "Inox" (Table 6).

Table 6. Example of a new code based on the proposed coding system

New code	123406

Field 1	12340
Field 2	6
Designation new item	Stainless steel hinge XPTO
Product line	Accessories
Family	Hinges
Subfamily	Inox

In terms of typical application, a new code for a new product is generated as previously mentioned.

New codes shall only be assigned to products which are already part of the codified system which has been amended if these changes are significant, that is to say, if it means a substantial change in the product, not considering, for example, the change of product code from the manufacturer.

For the introduction of a new product line, family or subfamily, that is, changes to the organization's basic classification structure, it is up to the responsible person or to the set of article authors to approve this situation making a proper change in the ERP.

6. Conclusions

Creating an unambiguous coding system preferably in the initial phase of company formation is of the utmost importance since this good practice will respond to its long-term needs [4].

However, companies usually start their business, more focused on guaranteeing their (over) existence, neglecting aspects that have substantial repercussions, mainly in the long term, such as the internal codification of their products.

An important aspect considering this theme are the norms and rules that underlie. Basic rules have been proposed to serve as a guideline for what has been thought, whether or not, given the definitions of the software, have a common thread. It is, therefore, necessary to follow a logical structure for the rules and norms that the codification presupposes [19]. It has been understood this is not the reason why companies work on a daily basis. It must be a matter that allows the work to work properly of companies. Thus, the aim of this work was completed with the suggestion of a codification manual that would facilitate the proper functioning of the organization under study.

The codification system Roadmap is intended to be simple to understand and apply since the subject in question requires it - the codification of articles should be a facilitator of daily activity that truly matters to industrial organizations.

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