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Understanding the importance of ISBN codes and creating a 13-Digit ISBN check digit

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ABSTRACT

This article provides a comprehensive review of ISBN codes, shedding light on their significance and outlining the process of generating a 13-digit ISBN check digit. ISBN codes (International Standard Book Number) play a crucial role in identifying and cataloging books, serving as a unique identifier for each publication.

Keywords: *ISBN codes, ISBN system, 13-digit ISBN check digit*

1. Introduction

International Standard Book Number codes (briefly, ISBN codes) are unique identifiers which are assigned to books and other published materials. They play a crucial role in the publishing industry, allowing for efficient cataloging, distribution, and identification of books worldwide. ISBN system was first discussed at the Third International Conference on Book Market Research and Rationalization (November 1966, Berlin) (Foster, Gordon,1966). At that time, a number of publishers and book sellers in Europe were considering the use of computers for order processing and inventory control and it was felt that a prerequisite for an efficient machine system was a unique and simple identification number for a published item. Each ISBN code consists of a 13-digit numerical sequence, though older versions may still have 10 digits. The code typically includes information about the book's publisher, country or language of publication, and the specific edition of the book. The check digit is used to ensure the correctness of the code, to prevent fraud and counterfeiting.

ISBN codes provide numerous benefits. These codes facilitate the management of book inventories, making it easier for booksellers and libraries to track and order specific titles. They also aid in the discovery of books through online databases, helping readers locate and purchase books with ease. Moreover, ISBN codes contribute to copyright protection and the standardization of bibliographic information. It's important to note that different formats of a book, such as hardcover, paperback, and e-book, typically have different ISBN codes. This allows for accurate tracking of sales and inventory across various formats (Bradley, 1992).

In addition, ISBN codes have applied in the identification and tracking of books and related products. ISBN codes serve as unique identifiers for each edition or variation of a book, allowing for efficient cataloging, distribution, and sales tracking in the publishing industry. They are important in identification and inventory management, efficient cataloging and discoverability, global distribution and supply chain management, marketing and sales tracking. ISBN codes help identify specific editions of books, including hardcovers, paperbacks, e-books, and different language versions. This enables accurate inventory management, preventing confusion and ensuring that the right book is available to customers. ISBN codes facilitate the organization and cataloging of books in libraries, bookstores, and online platforms. They enable quick searching and sorting of books by title, author, genre, and other metadata, making it easier for readers to discover and access desired publications (Charkin, Richard, 2015).

Moreover, ISBN codes enable smooth distribution of books across national and international markets. They provide a standardized system for tracking books throughout the supply chain, from publishers to distributors, retailers, and ultimately to the hands of readers. ISBN codes are essential for accurate sales tracking and reporting, helping publishers and authors monitor the popularity and success of their books. They enable sales data to be collected, analyzed, and used for marketing strategies, pricing decisions, and future publishing initiatives. ISBN codes contribute to intellectual property protection by uniquely identifying books and ensuring their authenticity. They help prevent counterfeiting and unauthorized distribution, safeguarding the rights of authors and publishers.

Finally, ISBN codes are vital tools in the publishing industry, ensuring efficient book distribution, accurate cataloging, and easy access to information for publishers, booksellers, libraries, and readers worldwide.

2. Preliminaries

The idea of developing the International Standard Book Number (ISBN) originated from the need to differentiate and manage information about books in library systems, local book inventories, and globally. The ISBN was designed to provide a unique identifier for each book, facilitating search, ordering, and efficient book inventory management.

The development of the ISBN began in the 1960s. Prior to that, identifying books in the international market was complex, with each country using its own system of coding. This posed challenges and complexities in tracking and managing book information when there were cross-border transactions.

In 1966, the International Library Network (ILN) initiated research and development of the ISBN system to address these issues. Subsequently, the ILN collaborated with the International Organization for Standardization (ISO) to establish international standards for the ISBN.

In 1970, the first version of the ISBN (ISBN-10) was introduced worldwide. The ISBN-10 initially consisted of 9 digits and a final digit that could be a number or "X" (representing 10). The ISBN-10 simplified the book management process and created a unified identification system for all countries globally. ISBN, which stands for International Standard Book Number, is a unique identifier used by sellers, publishers, and other relevant organizations to place orders, list and track sales, and more. The ISBN identifies the publisher, book title, edition, and other book-related information. The 10-digit ISBN can be divided into four parts: group identifier, publisher identifier, title identifier, and check digit. Group identifier identifies the region or country, and it can have a maximum length of 5 digits and a minimum of 1 digit. Publisher identifier code identifies the publisher of the book and has a maximum length of 7 digits. Title identifier code identifies the title or edition of the book and has a maximum length of 6 digits.

Later, in 2007, a new version of the ISBN was developed, known as ISBN-13. The ISBN-13 utilizes 13 digits and is divided into different groups of numbers, including country/language group, publisher, and specific book identification. The ISBN-13 provides more precise identification for each book and has been widely adopted globally.

3. Main Results

Create some new ISBN check digits

The ISBN has become the international standard for book identification, playing a crucial role in information management and book commerce worldwide. We provide the importance of ISBN codes in the following subsection.

3.1. Create some new ISBN check digits

ISBN is widely used by publishers, booksellers, and libraries to manage their book inventory. By assigning a unique ISBN to each book, they can accurately track the specific copies of books, manage the publishing history, and distribute books within their systems. This helps in organizing, searching, and efficiently managing book inventory. The importance of ISBN in Optimizing Book Inventory Management. A separate ISBN shall be assigned if there have been significant changes to any part or parts of a publication. A separate ISBN shall be assigned if there has been a change to the title of a

publication. A change to the cover design or colour or to the price of a monographic publication does not require a separate ISBN. Minor changes in an edition (e.g., corrections to misprints) do not require a separate ISBN (Bradley, 1992).

In the realm of the publishing industry, effective book inventory management is crucial for publishers, booksellers, and libraries. One of the key tools that aids in this process is the International Standard Book Number (ISBN). This unique identifier provides numerous benefits and streamlines the inventory management process. This article will delve into the significance of ISBN in optimizing book inventory management and discuss the potential challenges that arise in its absence.

Assigning a unique ISBN to each book allows for precise tracking of individual copies. Publishers, booksellers, and libraries can monitor the movement of books throughout the supply chain, from production to distribution. This enables efficient stock management, minimizes the risk of errors or duplication, and ensures accurate inventory counts.

An ISBN must be assigned to the whole set of volumes of a multi-volumed work. Where individual volumes of the set are available separately, each volume must be assigned a unique ISBN to identify it. The verso of the title page (or an equivalent position in a non-print version) in each case should clearly display the ISBN for the set as a whole as well as the ISBN for that particular volume.

ISBN facilitates the management of publishing history. By associating a specific ISBN with a book, publishers can record essential information such as edition, publication date, and format. This historical data aids in tracking revisions, managing reprints, and facilitating cataloging processes.

ISBN codes play a vital role in the smooth distribution of books. Booksellers and libraries can use ISBNs to order books from publishers or distributors with precision and ease. With ISBNs, they can easily identify the desired edition, ensuring that the correct book is obtained and delivered to the intended recipient. This streamlines the distribution process, reduces errors, and enhances customer satisfaction.

Intellectual property rights are of utmost importance in the creative industries, particularly in the publishing sector. Authors and publishers invest significant time, effort, and resources into producing original works. To protect their rights and prevent unauthorized use or distribution, a robust identification and tracking system is essential. The International Standard Book Number (ISBN) plays a crucial role in safeguarding intellectual property rights by providing a means of identifying specific books and establishing their origin and ownership.

Each book assigned an ISBN is provided with a unique identifier. This identifier serves as a digital fingerprint, distinguishing it from all other published works. It allows for precise identification and differentiation of individual titles, editions, and formats. By associating a specific ISBN with an author and publisher, the ISBN system aids in

establishing the origin and ownership of a book. It ensures that the intellectual property rights are properly attributed to the creators and provides a traceable record of the book's publishing history.

ISBN is closely linked to copyright protection. The ISBN helps authors and publishers assert their rights over their creative works. Copyright laws vary from country to country, but having an ISBN attached to a book strengthens the legal protection and assists in enforcing copyright claims. The unique identification provided by ISBN helps in preventing unauthorized use and distribution of copyrighted material. It enables monitoring and tracking of book sales, making it easier to identify and address instances of piracy, counterfeiting, or unauthorized reproduction.

The ISBN system is internationally recognized, providing a standardized identification format for books across different countries and markets. This global recognition enhances the credibility and protection of intellectual property rights, making it easier for authors and publishers to navigate the international publishing landscape. ISBN provides a standardized identification system for commercial transactions involving books. Through ISBN, retailers and distributors can manage inventory, place orders, and track sales revenue for specific books. It enables the establishment of a standardized and convenient book business system, facilitating book trade, and streamlining transactions between publishers, retailers, and customers. ISBN has significant applications in book inventory management, intellectual property protection, and facilitating book business. It enables efficient tracking, ensures copyright protection, and supports commercial operations in the book industry.

Intellectual property rights are of utmost importance in the creative industries, particularly in the publishing sector. Authors and publishers invest significant time, effort, and resources into producing original works. To protect their rights and prevent unauthorized use or distribution, a robust identification and tracking system is essential. The International Standard Book Number (ISBN) plays a crucial role in safeguarding intellectual property rights by providing a means of identifying specific books and establishing their origin and ownership.

Some examples of publishers' products to which an ISBN shall be assigned are:

- Printed books and pamphlets;
- Individual chapters or sections of a publication if these are made available separately;
- Braille publications;
- Publications which are not intended by the publisher to be regularly updated or continued indefinitely;
- Individual articles1 or issues of a particular continuing resource (but not the continuing resource in its entirety);
- Maps;

- Educational/instructional films, videos and transparencies;
- Audio books on cassettes or CD or DVD (talking books);
- Electronic publications either on physical carriers (such as machine-readable tapes, diskettes, CD-Roms) or on the Internet (for download or streaming);
- Digitised copies of print monographic publications;
- Microform publications;
- Educational or instructional software;
- Mixed media publications (where the principal constituent is text-based).

Next, we will show how to make a new 13-digit ISBN code by using the 10 modular congruence equation and the new ISBN check digits examples.

3.2. How to create a 13-digit ISBN check digit

The ISBN is a unique string of digits used to identify books. The ISBN is a code consists of 13 digits $d_1 d_2 ... d_{13}$, which d_1 through d_{12} are the first digits of the ISBN and d_{13} is the check digit.

The check digit, *13*th digit of the ISBN, which is the last digit of the ISBN, must be from 0 to 9 such that the sum of all thirteen digits, each multiplied by its (integer) weight, alternates between 1 and 3, which is a multiple of 10. That is, the sum satisfies the following check equation:

$$\left(d_1 + 3 \times d_2 + d_3 + 3 \times d_4 + ... + d_3 + 3 \times d_{12} + d_{13}\right) \equiv 0 (mod 10).$$

Since the *13*th digit of the ISBN is a subset of the 13th digit of EAN, the algorithm for calculating the check digit is exactly the same for both. The calculation of the check digit begins with the first twelve digits of the 13 digit ISBN (thus excluding the check digit itself). Then, the weights corresponding to the first 12 numbers is 131313131313. And it is done in the following 5 steps:

1. Each digit of the first 12 numbers from left to right is multiplied by the corresponding weight,

2. Next, sum the multiplications just calculated by mod 10 to give the value between 0 and 9,

3. Then subtract 10 from the number you just calculated , the result is a number from 1 to 10,

4. Go ahead, if the result in step 3 is 10, we replace it with 0, so in any case the result is a check digit,

5. Finally, take the newly calculated check digit and join it with the first 12 digits. Thus, we have the ISBN check digit to find.

Therefore, assigning the check digit $d_{13} = x$ we have the congruence equation to calculate the check digit of the ISBN code as follows. Let

$$10 - \left(d_1 + 3 \times d_2 + d_3 + 3 \times d_4 + ... + d_3 + 3 \times d_{12}\right) mod\ 10 = x.$$

Then

$$x_{13} = \begin{cases} r, & r < 10 \\ 0, & r = 10. \end{cases}$$

The barcode system was introduced into practical library information work, especially in industrially developed countries like the United States and France, around the early 1980s, particularly after the establishment of the International Standard Book Number (ISBN) and International Standard Serial Number (ISSN). This system aimed to control the sources of books and periodicals on a global scale and was closely related to the process of computerizing libraries.

In the late 1980s, some member countries of the ISBN system achieved a new level of dialogue organization on machines and electronic verification of order processing. The numeric codes were improved to be machine-readable. Barcodes were reflected on various types of goods, including published products from many countries. Among various barcode formats, the European Article Number (EAN) format gained popularity worldwide.

In many countries, barcodes were used as identifiers for book shipments through postal services. For example, in the United States, there were standards for barcode information on book shipments, which included the ISBN, price, quantity sold, cover type, quantity ordered, and order number. The first remote book ordering systems based on barcodes were implemented in the Federal Republic of Germany in the mid-1980s. The remote book ordering system was a combination of electronic systems that checked inventories, researched reader demands, connected publishers' order systems, and libraries. Its foundation was the direct communication between terminal computers and directory information sources.

In the United States, France, and the United Kingdom, an automated system for cataloging and remote book distribution has been implemented, utilizing devices for tracking all operations and preparing barcode labels. The labels are affixed or attached to the books. The labels of sold books are retained by the seller for additional inventory management, with the barcode automatically reproducing the ISBN.

By the late 1980s, some libraries in certain states of the United States adopted barcoding to control the process of materials checkout, linked to the online public access catalog (OPAC).

During the same period, in Latin America, several national ISBN agencies, including Brazil and Chile, made significant efforts in researching the implementation of barcode indexing. In the UK, the Kemble Library of the University of London developed an

automated check-in system using 56 terminals and barcode scanning devices, which were connected to electronic cataloging systems and data preparation systems. Similar trends emerged in many other countries. Numerous libraries in India and Southeast Asian countries also began using barcodes in their reader services.

In Vietnam, the implementation of barcode systems in library circulation is widely adopted. The leading organization in using ISBN barcodes is the National Center for Scientific and Technological Information, followed by libraries in natural science universities, technical pedagogical universities, and agricultural universities.

The library systems have employed software to store and access information about library users and relevant materials for borrowing. The software utilizes barcode reading technology to identify the barcodes printed on specially labeled circulating materials and borrower cards.

Firstly, a database is constructed containing information about library users, including their user ID, card number, address, phone number, workplace, occupation, etc. The user ID is entered into the user database and encoded as a barcode to be attached to the borrower card. A second database contains information about books, such as book titles, authors, book codes (call numbers), publishers, publication years, etc. This information is also encoded as barcodes and attached to the books according to the database.

When a library user borrows a book, they present their borrower card. The library staff puts the system in borrowing mode and scans the barcode on the borrower card using a barcode reader, followed by scanning the barcode on the desired book. The computer system records all the information about the user borrowing specific books, including the book titles, call numbers, borrowing duration, etc.

When a user returns a book, the library staff puts the system in the return mode and scans the barcode on the borrower card, followed by scanning the barcode on the returned book. The computer system automatically marks the book as returned and records the return date and time. The book is then returned to the library collection and becomes available for other users. The library staff can access information about the status of books and users, such as books currently borrowed, overdue books, and the number of days overdue.

The ISBN codes serves as a key element in the ordering and inventory management system for publishers, booksellers, libraries, and other organizations. It provides a foundation for collecting data on new editions and subsequent printings of reference publications for use in commercial book trade catalogs. The use of ISBN codes even facilitates the management and monitoring of data sales rights within the publishing industry.

Previously, the ISBN codes were not mandatory in publishing activities, and book producers could choose to apply it or not. The inclusion of ISBN codes in publishing regulations would provide a favorable condition and ensure consistency in book management.

Through the ISBN codes, the governing body gains an additional tool for book management. Furthermore, books from Vietnam have a gateway to the world through the ISBN system.

Here are some examples of new ISBN codes that we built based on the above congruence equation.

Example 3.1. To generate a new ISBN with the first 12 digits is 978316148410. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$\begin{aligned} x &= 10-(9\times1+7\times3+8\times1+3\times3+1\times1+6\times3+1\times1+4\times3+8\times1+4\times3+1\times1+0\times3)\bmod 10\\ &= 10-(9+21+8+9+1+18+1+12+8+12+1+0)\bmod 10\\ &= 10. \end{aligned}$$

Since the result of the above calculation is 10, the check digit of the new ISBN is 0, so we will add a zero to the end of the string and the new ISBN will be 978316148410-0.

Note that this calculation is according to the conventions of each region, each country, some countries will subtract 10 as above, but there are also countries that take the value of mod 10 (like the example above of modular 10 work out number 0, the number 0 will be taken as the check digit.)

However, if you are in Vietnam, you will agree on the general way (regulations of the Department of Culture) is to use weights 1 3 1 3 1 3 1 3 1 3 1 3 and will calculate as the example mentioned above. Here are some more examples of how to generate a new ISBN using the congruence equation.

Example 3.2. To generate a new ISBN with the first 12 digits is 978014044911. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+0\times3+1\times1+4\times3+0\times1+4\times3+4\times1+9\times3+1\times1+1\times3)\bmod 10=2.$$

The check digit of the new ISBN is 2, so we will add 2 at the end of the string and the new ISBN will be $978014044911-2$.

Example 3.3. To generate a new ISBN with the first 12 digits is 978052187858. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+0\times3+5\times1+2\times3+1\times1+8\times3+7\times1+8\times3+5\times1+8\times3)\bmod 10=6.$$

The check digit of the new ISBN is 6, so we will add 6 at the end of the string and the new ISBN will be $978052187858-6$.

Example 3.4. To generate a new ISBN with the first 12 digits is 978020161588. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+0\times3+2\times1+0\times3+1\times1+6\times3+1\times1+5\times3+8\times1+8\times3)\bmod10=3.$$

The check digit of the new ISBN is 3, so we will add 3 at the end of the string and the new ISBN will be 978020161588 − 3.

Example 3.5. To generate a new ISBN with the first 12 digits is 978026203384. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+0\times3+2\times1+6\times3+2\times1+0\times3+3\times1+3\times3+8\times1+4\times3)\bmod10=8.$$

The check digit of the new ISBN is 8, so we will add 8 at the end of the string and the new ISBN will be 978026203384 − 8.

Example 3.6. To generate a new ISBN with the first 12 digits is 978080413738. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+0\times3+8\times1+0\times3+4\times1+1\times3+3\times1+7\times3+3\times1+8\times3)\bmod10=6.$$

The check digit of the new ISBN is 6, so we will add 6 at the end of the string and the new ISBN will be 978080413738 − 6.

Example 3.7. To generate a new ISBN with the first 12 digits is 978142218641. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+1\times3+4\times1+2\times3+2\times1+1\times3+8\times1+6\times3+4\times1+1\times3)\bmod10=1.$$

The check digit of the new ISBN is 1, so we will add 1 at the end of the string and the new ISBN will be 978142218641 − 1.

Example 3.8. To generate a new ISBN with the first 12 digits is 978150112606. Then, the weights corresponding to the first 12 digits is 131313131313. Therefore, we will calculate the check digit x by:

$$10-(9\times1+7\times3+8\times1+1\times3+5\times1+0\times3+1\times1+1\times3+2\times1+6\times3+0\times1+6\times3)\bmod10=2.$$

The check digit of the new ISBN is 2, so we will add 2 at the end of the string and the new ISBN will be 978150112606 − 2.

Thus, based on the congruence equation, we can generate a new ISBN check digit and also easily check the correctness and alter of the available ISBN check digits.

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