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The design and implementation of barcode-based inventory and marketing management systems

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Abstract

Opportunities and challenges for bar codes as a means to support complete supply chains are being created by the pursuit of increased industrial productivity, better customer service, improved inventory accuracy, enhanced buyer/seller communication, inventory and marketing cost savings, and higher quality standards. This article presents a conceptual framework and methodology for developing and implementing a bar-code system for use in inventory and marketing. Integration of a bar-code system into a company's inventory marketing management is discussed, along with its advantages, drawbacks, and potential answers.

Keywords: Bar code; Inventory management; Inventories; Marketing management; Information systems

1. Introduction

In order to effectively manage and control marketing and inventory levels, it is essential to gather and communicate relevant data. There is little doubt that bar-code technology is, and will continue to be, at the forefront of automated identification [1,2]. Integration with existing enterprise systems is a major hurdle for bar code technology. The bar code is rapidly becoming the standard method of automated item identification in many commercial and industrial settings, most notably the retail trade across the globe [3].

Information on customers and their purchases is readily available at the time of sale, which helps shops implement relationship marketing strategies. Bar-code scanning for automatic data gathering is the most efficient front end of any inventory management system [4]. This article investigates how inventory and marketing information systems might benefit from using bar-code technology. We also show and assess the sequential steps of a model for creating and deploying a bar-code system, keeping in mind the unique challenges that this kind of system poses. Finally, a case study is used to explore the advantages, drawbacks, and potential solutions related to these phases and the integration of bar-code technology as a method to enable whole supply chains.

2. The incorporation of bar-code technology

Bar coding is being employed to improve the accuracy of information and speed the transmission of data. It is being utilized throughout the business [3]. Inventory and marketing management processes provide tasks in which bar-code technology can be incorporated [5]. The technology has become increasingly visible during the past decade, thanks to its widespread use in inventory/warehouse management, in supermarkets and other operations mainly in the retail sector [6]. In today's world of warehousing and distribution, companies are depending more heavily on bar-code systems to keep track of their inventories, and to ensure efficient flow of product in and out of the warehouse [7]. Bar-code scanning is proving to be an effective tool toward achieving inventory control [8]. The bar code is the dominant technology at point of sale for item identification [9]. Point of sale terminals are normally connected to a host computer which receives sales information from the terminals. The host computer can thus be used to automatically reorder items whose inventory levels have fallen below a predetermined point, taking into account current inventory levels. Scanning of bar codes may be a useful tool in determining the effectiveness of particular marketing policies.

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Bar-code systems enhance interorganizational and further business relationships by connecting data systems and encouraging information sharing. In Fig. 1, a conceptual framework for the integration of a bar-code system in inventory and marketing information systems is presented using the bar-code technology as an enabler for effective supply chain management. The development of a bar-code

system and the installation of electronic point of sales (EPOS) systems have a major impact on the availability and quality of information on the markets for many consumer products. Bar-code systems incorporated to the inventory and marketing information systems can provide information on stock item identification, price, sales by stock item, sales by

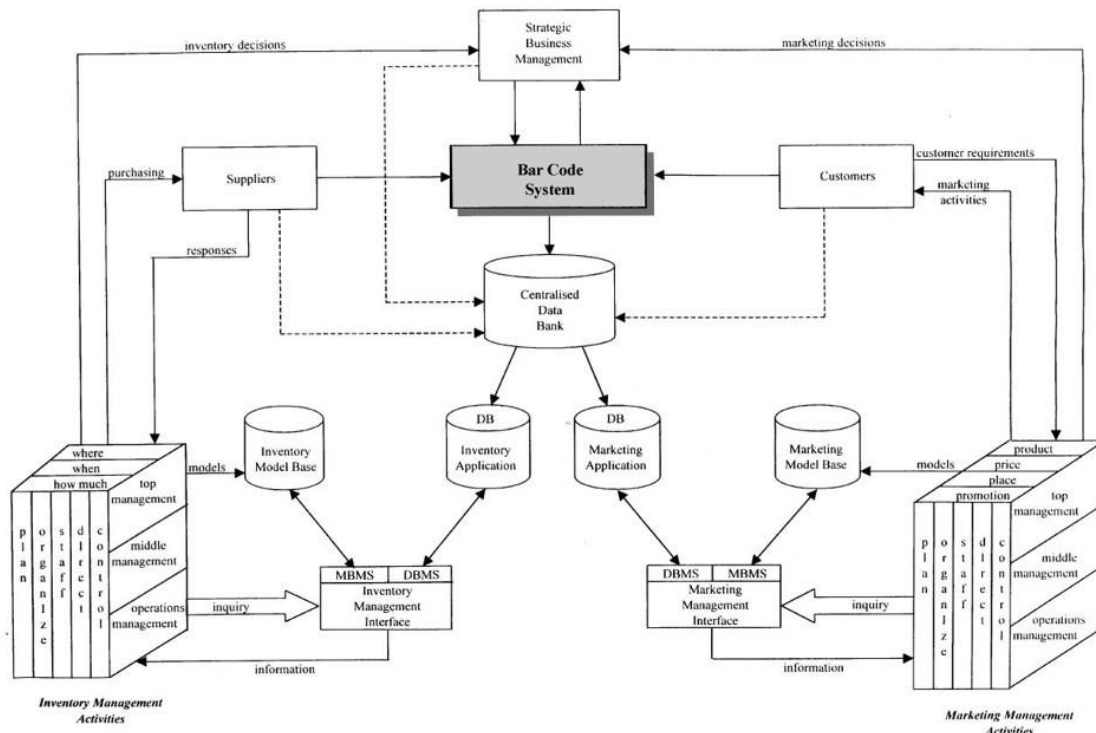


Fig. 1. Integration of a bar-code system in inventory and marketing: a conceptual framework.

department, sales by store, sales by in-store area location, fast moving stock items, slow moving stock items, hourly or daily or weekly sales, sales by customer, sales by state, inventory analysis, analysis of exception reporting, profitability/contribution by stock item, and transaction type (cash, credit card, switch card, cheque, etc.) [10,11]. External research agencies which have traditionally supplied this type of data by surveying samples of outlets on a regular basis will find that their data is less up-to-date than that supplied by a bar-code system. EPOS systems can provide significant improvements in inventory management and control [12,13]. The improvement of information on inventory levels, enables retailers to move nearer to Just in Time purchasing systems, and electronic data interchange system (EDI) requiring their own suppliers to become increasingly flexible in the timing and quantity of deliveries, as well as the variety of products [14]. The role of inventory managers is to plan requirements and manage

finished inventory from production until customer shipment. Decisions include 'where, when and how much'. Inventory decisions are supported by simple reactive models to more complex ones which are activated by data stores in a specialized data base for inventory applications. These models respond to current demands and inventory environment on the basis of reorder point and order quantity parameters [15]. Thus, they support replenishment decisions by reacting to current inventory levels. In addition, to enhancing the management of inventory, such systems also have considerable potential as a source of marketing information. The marketing managers utilize the databases and the model bases to make their decisions on products, pricing, advertising/promotion, distribution, and packaging, under the constraints imposed by the internal and external environment. This process is integrated into the organizational strategies and decision-making processes to support all levels of

marketing functions } planning, organizing, staffing, directing, and controlling. Decision and sales managers of key problems and opportunities and to provide them with daily problem solving information. Additionally, expert systems have been designed to find important facts and trends in databases collected through bar-code scanners in grocery stores [16]. The integration of bar-code systems with inventory and marketing management information systems into the context of supply chain management strategy, increases the efficiency, profitability, and competitiveness of the company. Summarizing, the specific primary benefits of bar coding include: A reduction in errors at the cash register, checkout line throughput improvement, inventory control and management improvement, buyer's and seller's communication enhancement, auditing the marketing policy effectiveness, availability of improved data for consumer market research results, flexibility to changing customer requirements [7,17]21].

1. Bar-code development and implementation process
The development and implementation of a bar-

support systems can be developed in order to manage the process of informing all marketing code system will affect almost every part of a company. A sound strategy and careful preparation are the key elements to avoid possible future drawbacks [22]. A model for the development and implementation of a bar-code system from the initial stages of the proposal's submission in relation to the strategic business plan to its installation and evaluation is presented in Fig. 2. The model is inherently iterative. A guideline of the specific stages of the model for the development and implementation of a bar-code system related to data information input, sources of the data, and the actions taken is presented in Table 1 [23].

1.1. Preliminary investigation

Bar coding should not be identified as the solution before the company's goals are defined. Typical goals may be reduction of errors, timely data for inventory control, determination of marketing policy effectiveness, and improvement of customer service [7,24]. Setting project goals early on will be of great help later when making the inevitable decisions on what is of critical importance.

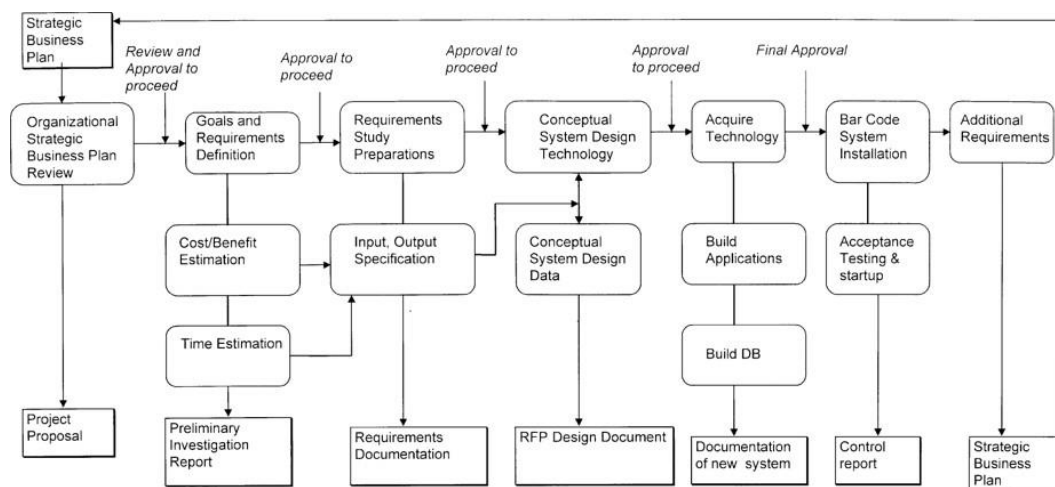


Fig. 2. A model for the development and implementation of a bar-code system.

1.2. Systems analysis study

Bar-code systems are operable while a physical event takes place (i.e. sales, inventory control, physical distribution) so a detailed analysis of the above events and their timing is required in order that the proposed bar-code system will not become an operational bottleneck. The bar-code system will be required to interface into other

systems in the firm. During this stage interaction with users from various organizational levels from sales and distribution management, warehouse and logistics, accounting, and production management is also required, in order to understand potential conflicts and to integrate their objectives.

1.3. Systems design

Hardware and software selection for a bar-code system depends on company's environmental

factors [25]28]. Criteria such as required level of updated information in the host system, amount of information to be sent in any single transmission,

existing working environment, and budget will affect the interface options decision. The effect of data structure on the rest of the system is the response time of the bar-code system, and the duration time of transmission to the host computer. These systems are never independent,

3.4 .Development

At this stage the system is actually constructed and detailed documentation is

3.5 .Implementation and evaluation

After loading the inventory and marketing data, a thorough test of the system is essential to make sure it works correctly. Users in the affected departments are allowed to make suggestions for improvement. Training of the users who interact with the system will help

2. Case study

The stages for the development and implementation of a bar-code system, as well as, its integration in the inventory and marketing information system of a company, were examined in a case of a drug-store supermarket chain. The investigated company is constituted of three units with common ownership in Northern Greece. In all the stores, point of sale systems are used, which incorporate a bar-code reader, a printer and keyboard built into each check-out point. The information that can be gathered from the bar code is the price of the product, the type, its origin, inventories available, as well as the demand of the product. The purchased items are scanned and the bar code identifies the data regarding the item. The description of the item and its price are then looked up automatically by the computer, and the price of each item is displayed and printed at the check out point. A printed receipt including the quantity, description, price and amount of all purchases is provided to the customer. The types of bar code used depend on the product. universal product code (UPC), was used for products imported from the States, and European article number (EAN) for European products. The company also applies its own code on which the selling price of the product is included. The introduction of the bar-code system was part of an overall plan of the company, to automate all operational transactions. The development and implementation of the system was assigned to a private software company. The adoption of the model was inefficient due to organizational, business and technical conditions that necessitated the immediate application. The initial goals for the bar-code application were basically: reduced costs, improved customer service, and increased efficiency. A detailed

and if a good planning technique is not used at the design stage integration problems will arise. Any changes needed should be designed and documented in detail. A request for proposals (RFP) will ensure that both the project team and the vendor understand what is to be delivered.

required. End user and management review and approval is also obtained.

them get familiarized with the new processes [29]. Although a bar-code system will increase productivity, efficiency and accuracy, a post-audit is needed to review options as they have been changed and to determine new performance levels.

preliminary investigation report was not submitted. Approval of management was given after receiving a general report including cost, time and benefit estimation. Affected business areas were not included in this stage. During the analysis stage working procedures of other business departments were examined, restricted at the operational level overlooking the potential support of the information received from the bar-code system at the strategic level. Marketing and inventory managers were not involved during this stage. Emphasis was given only to the integration with the accounting department.

After the implementation several problems have emerged due to the inefficient use of the model. Discrepancies appeared between the prices shown on store shelves and those displayed and registered at the check out point. These discrepancies occurred when prices changed and had not been remarked on the shelves. In the store units paper price labels were manually applied to shelves and display area. This was a costly, labor intensive, and error-prone operation. To solve this problem an electronic replacement for paper labels was installed, so that all price changes are registered simultaneously. Training was carried out gradually. Before the system was installed some cashiers were trained to use the system.

Unfortunately, the entire staff was not trained at the same time. As a result, the first three months problems occurred at the check out points. After installation training continued to the middle and top management of affected departments. After the training a growing interest was shown by marketing and inventory managers for the integration of bar-code information in inventory and marketing strategic decisions.

The additional requirements have been approved and analysis of the working procedures is re-examined using the model. The suggested goals and actions that can be achieved are the following: An analysis of sales can be provided so that sudden surges in demand are detected at an early stage through a triggering an exception report. The data collected by bar-code systems can be organizational, business and technical conditions that necessitated the immediate application. The initial goals for the bar-code application were basically: reduced costs, improved customer service, and increased efficiency. A detailed preliminary investigation report was not submitted. Approval of management was given after receiving a general report including cost, time and benefit estimation. Affected business areas were not included in this stage. During the analysis stage working procedures of other business departments were examined, restricted at the operational level overlooking the potential support of the information received from the bar-code system at the strategic level. Marketing and inventory managers were not involved during this stage. Emphasis was given only to the integration with the accounting department. After the implementation several problems have emerged due to the inefficient use of the model. Discrepancies appeared between the prices shown on store shelves and those displayed and registered at the check out point. These discrepancies occurred when prices changed and had not been remarked on the shelves. In the store units paper price labels were manually applied to shelves and display area. This was a costly, labor intensive, and error-prone operation. To solve this problem an electronic replacement for paper labels was installed, so that all price changes are registered simultaneously. Training was carried out gradually. Before the system was installed some cashiers were trained to use the system. Unfortunately, the entire staff was not trained at the same time. As a result, the first three

3. Conclusions

Bar-code systems offer to the companies who have adapted it a definite commercial advantage in efficiency and customer service over their slower competitors. Bar-code systems are almost never independent by nature. Such systems are rich with potential integration problems, which can be avoided if a good planning technique is used. The model presented in the paper shows how these systems could be developed and implemented following a structural procedure, as well as their place and importance in inventory and marketing management systems. The stages from the initial step of the project's proposal to assuring its suc-

cessful implementation are analyzed, taking into consideration issues which have special significance for bar codes. Bar codes provide accurate inventory control at the store level, and facilitate replenishment since actual unit sales can be quickly communicated to the supplier. Tracking actual sales reduces uncertainty and allows better inventories to be removed. In our case study, bar-code technology has been used in order to automate daily transactions resulting in reduction of cost and human error during data entry operations. The original goals have been achieved, and emerged problems during implemen-

months problems occurred at the check out points. After installation training continued to the middle and top management of affected departments. After the training a growing interest was showed by marketing and inventory managers for the integration of bar-code information in inventory and marketing strategic decisions. The additional requirements have been approved and analysis of the working procedures is re-examined using the model. The suggested goals and actions that can be achieved are the following: An analysis of sales can be provided so that sudden surges in demand are detected at an early stage through a triggering an exception report. The data collected by bar-code systems can be stored and analyzed, providing the local store manager with a considerable amount of information which can be used in decisions about store layout or the evaluation of the effectiveness of local promotions and price changes. Furthermore, it can be analyzed at an aggregate level for all the units and used by the central marketing department to plan marketing actions and monitor their effectiveness. Apart from real-time control over inventory, information output from bar-code systems can be used to automatically update inventory levels and support inventory decisions about suppliers selection, warehouse control, distribution resource planning (DRP), just in time systems and EDI. Cost/benefit analysis, management commitment and environmental factors will determine the continuation of the project.

As problems emerged a feedback process following the stages of the model took place. Thus, the initial goals of the company for the implementation of the bar-code system in general terms have been achieved. Benefits include accuracy of data, availability of timely data, improved register check out productivity, increased levels of controls, customers service, reduced physical inventory time, and increased system flexibility.

successful implementation are analyzed, taking into consideration issues which have special significance for bar codes. Bar codes provide accurate inventory control at the store level, and facilitate replenishment since actual unit sales can be quickly communicated to the supplier. Tracking actual sales reduces uncertainty and allows better inventories to be removed.

In our case study, bar-code technology has been used in order to automate daily transactions resulting in reduction of cost and human error during data entry operations. The original goals have been achieved, and emerged problems during implemen-

tation have been resolved using the model in the feedback process. The system though could provide information affecting other business units to support strategic decision-making. In order to take advantage of this information, the company is already in the process of analyzing the integration of bar-code systems for inventory and marketing information systems. Budgetary, organizational, environmental and technical conditions will affect the degree of integration and the specific technologies (i.e. just in time, EDI) which can

be incorporated.

Bar coding connects data systems and encourages information sharing. Improved information technology lowers processing cost for orders, reduces planning and operating uncertainty, and assists an enterprise in meeting strategic objectives. However, information can provide a competitive advantage only when it can support transaction, management control, decision analysis and strategic planning capabilities.

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