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THE EVALUATION OF BARCODE SYSTEM IMPLEMENTATION IN PT. NUTRICELL PACIFIC

Carolyn Hong Gui Qing and Sulistyo Heripracoyo

Information Systems Department
School of Information Systems
Bina Nusantara University
Jl. K. H. Syahdan No. 9, Kemanggisan, Palmerah, Jakarta 11480, Indonesia
Carolyn.ging@binus.ac.id; hpracoyo@binus.edu

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Abstract. *PT. Nutricell Pacific is a private feed additive manufacturing industry located in Tangerang, where they implement barcode system in their production department for 10 months. They applied QR code as their products information storage. The main goal of this research is to evaluate the barcode system from the system perspective in the aspect of efficiency and effectiveness, identify the valid factors which affect the overall performance and find alternative solutions. Without official overall audits, the company could not detect the possible issue or technical improvements required. Hence, by using DeLone and McLean success model variables and system evaluation theory as the qualitative approach could find the potential elements and determine the current efficiency and effectiveness. Based on hypothesis testing, interviews and 15 respondent questionnaires, the findings of this research will reveal the factors which affect the worker's performance in interacting with barcode system. The possible factors consist of system quality, information quality, user satisfaction and organization impact. Accordingly, through the methodology applied, the results certainly show the efficiency and effectiveness according to the workers and systems interaction lenses and not from the technical perspectives.*
Keywords: Barcode system, System evaluation, Efficiency and effectiveness, DeLone and McLean success model, Manufacturing industry

1. **Introduction.** The advancement of industrialization indulges systematic and technology interference and corroboration in many aspects. As a middleman of human and machines, digitalization became the advanced step of approaching futuristic industries. The inclination demands of technological adaptation in industries initiated from the automation needs in the manufacturing industry. Due to the uprising of supply chain management and stock inquiries, barcode system is one of the ultimate solutions for the manufacturing industry. The barcode is a wealth asset responsible to store data and information in the ownership of the industry. The barcodes invention in 1970s, defined as a vertical line block differentiates by specific width of line sizes, numbers, and letter encoding [1]. Barcodes system is generally known among inventory management scope, but the implementation within the internal production department is a fresh perspective in the manufacturing world. Although the main aims of industries using barcode system are improving efficiency, accuracy, traceability, security and time saving, the attempt to apply barcode system in every production phase needs an evaluation breakthrough. The novelties of various previous studies which are relevant to these days around the industries topic such as E-commerce, ERP implementation, student loan industry, government, and other companies field assure DeLone and McLean success model is the right tools for this research [2-6]. While there are no significant researches of barcode system efficiency and effectiveness in feed additive manufacturing industry, the motivation to conduct the

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barcode system evaluation research is to share the profound knowledge and information of system perspective evaluation. In this research context, the research questions are 1) Does the current barcode system implementation efficient and effective? 2) What are the factors of system performance in the overall process? and 3) Is there any recommended solution to improve the current application in the long term? The final results will reveal the evaluation results of efficiency and effectiveness, identify the valid factors which affect the overall organization performance and suggest an alternative solution for PT. Nutricell Pacific barcode system. PT. Nutricell Pacific is a feed additive manufacturing industry located in Tangerang. They produce high quality premixes that focus on customer and value creation concept. PT. Nutricell Pacific's mission is to play an important role in producing healthier, safer and sustainable products to meet customer expectations and adopt the latest technology, while their vision is to fulfill the science of life. They collaborate with barcode system and use QR code as their products identifier. After a 10 month period of barcode system running in the production department, evaluation research is a preliminary step before the company partakes an official audit and has a clarity of how efficient and effective are the barcode systems contemporarily.

2. Literature Review.

2.1. **Definition of barcode.** Joe Woodland stumbled on his fun doodle in his holiday which is claimed as a Morse code, earning the patent in 1949 [7]. Lavery describes barcode as a data display bounded by governing rules, a visual pattern of bars, numbers and letters encoded with information for product and price tracking [1]. Barcode is a reliable information storage of product's identity, by securing it in encryption and scanning with barcode scanner to display the information on screen [8]. Their popularity rose when they enter automotive and supply chain industry sector. Alphanumeric characters rose the demands of upgradation while influencing stakeholder perception of traditional 1 dimensional barcode to appear limited and weak.

2.2. **Definition of QR code.** QR (Quick Response) code is a trademark matrix code filled with black and white box. ISO granted QR code is recognized as a universal identification code, which is firstly applied in an automotive industry in 1994 [9]. 2 dimensional barcode is user friendly and consists of unique properties which made them suitable for mobile application. QR codes are flexible due to its capability of containing 177 modules which encode 4,464 characters, and 7,336 digits or 3,706 bytes. In general terms, 2 dimensional barcode equips vision technology known as a Charge Coupled Device (CCD) image sensors. CCD is used to capture decoding information [2].

2.3. **Pro and cons.** The strength of 1 dimensional barcode lies in its speed reading, robust performance through laser scanner and mobile application usage. Barcode utilization is more affordable and promising as the universal tagging labels for product could identify products and assist inventory tracking. The drawback of 1D barcodes is their limited alpha numeric characters and excluded symbols, including the large size resultant of actual implementation of small part identification [2]. Thus, 2D barcodes pros are their automatic and semi-automatic, fast, data acquisition ability along with enhanced accurateness, and exposure to information display for every personnel ubiquitously. Some restraints both 1D and 2D own within a few aspects, encompass the barcode's ability to scan one product at once, limited distance between the barcode scanners and barcode label (product), environmental factors (humidity, high pressure, dust or severe temperature rising) [8]. 1D and 2D barcode reserves convenience and quicker way to retrieve data by simply scanning barcode labels, then tracking and displaying the information within the software on screen or desktop.

2.4. **Barcode systems process.** Shams clarifies that barcode implementation process for every industrial field scope may differ slightly, but the major processes will always be similar [10]. Barcode system process consists of 1) scanning the barcode label containing 1D or 2D codes within the distance range of the barcode scanners for efficient scanning in one swipe, 2) data processing can retrieve through software recalling from the database into display, as in smartphone complete module (it entails the light source module and electrical module of communication and housing to support the module positions), 3) patterns are decoded, converting from the encryptions into text characters – extract storage information for the user in counts of seconds.

2.5. **System evaluation.** A process of gathering success and failure evidence to meet system requirement and advised assurance target [11], is also known as a strategic program to assist the managers to decide on the strategies success rate, especially for assessing performance either in model construction or usage [12]. System Evaluation Theory (SET) builds a strong evaluation foundation to identify problem and transformation attempt to reveal results and efforts for other researchers' to consider for usage [13,14]. Renger stated the most critical effectual pre-planned components considering to proceed the evaluation process, comprising system boundaries, subsystem processes, system attributes, system feedback mechanisms, inputs and common goals [14,15].

2.6. **DeLone and McLean success model.** As the synthesized product of old information conversion to a new knowledge capsule, this model is flexible for modification due to context requirement [16]. Multidimensional success was postulated according to the fact that the technical level of communication is equivalent to accuracy and effectiveness to produce information. As the semantic level indicates how well the information conveys their meaning and effectiveness level depends on recipients' comprehension. To summarize, "system quality" means technical success, "information quality" means semantic success, as for "use, user satisfaction, individual impact, and organization impact" means effectiveness success [12]. Gable and Chan assert that some variable dimensions corroborate to produce certain impact from one variable to another, for instance, some derivatives of information quality, system quality and individual impact are indirectly measured in satisfaction terms [17].

3. **Methodology.** The methodology applied in this research is the combination of qualitative and quantitative approach. In terms of qualitative approach, the authors conduct data collection through interviews with three stakeholders, observations on field and method triangulation of journal collections and real data. As for quantitative approach, the authors gather 15 respondents based on purposive sampling [18,19]. The criteria based respondents are the workers who have worked at least for a year, have an average of one year interaction with barcode system and belong to the operation department. Data are collected through both online and offline questionnaire according to Likert scale 1 to 4. The system evaluation theory guided the evaluation and analysis of the barcode system, in addition of questionnaires analysis and literature study. Moreover, the quantitative analysis includes using SPSS to test the hypothesis and determine the multi regression relationship of each variable. There are four hypotheses. The first stated system quality does not affect user satisfaction partially. The second hypothesis stated that information quality does not affect user satisfaction partially. The third hypothesis stated that both system and information quality do not affect user satisfaction simultaneously. Lastly, the fourth hypothesis stated that the user satisfaction does not affect organization impact partially. Multi regression methods comprise r square, t test and f test. r square is used to measure dependent variables variation by independent variables elaboration. t test is used to test the hypothesis by comparing the means of both samples through t value using t distribution. Meanwhile, f test is used to test the significance of the null hypothesis that

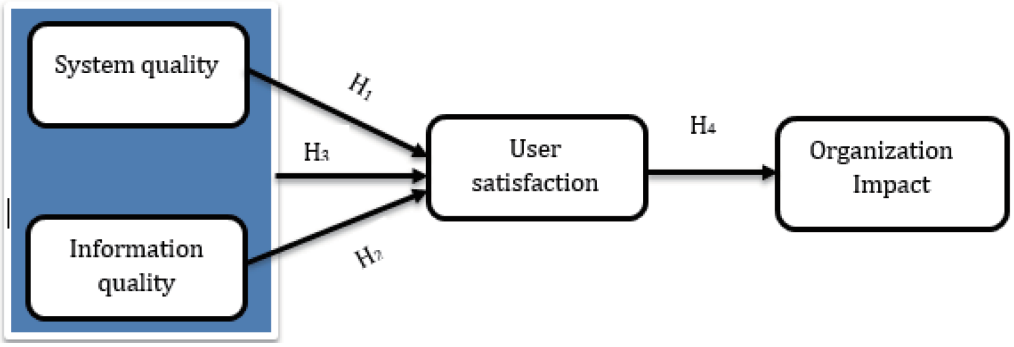

FIGURE 1. Hypothesis model

the multiple determination coefficient is zero, in order to discern the close relationship between independent and dependent variable [19-21].

4. Results and Discussion.

4.1. **Hypothesis testing and multi-regression results.** The hypothesis testing and multi-regression analysis acquires measurement from r square, f test and t test decisions. In the first hypothesis, it proves that system quality does not affect user satisfaction. Because the r square contains 12.1% effects, 0.071% of variance, and both the f test and t test are smaller than the f and t table, system quality is proven with no significant partial effect toward user satisfaction. The second hypothesis contains 0% of effects and weak variance, as a dependent variable, the f test and t test prove that information quality does not have a significant partial effect toward user satisfaction. The third hypothesis displayed 0.121 and −0.503 incline variation, r square of 20.7% shows that both system and information quality does not affect user satisfaction significantly. As for the last hypothesis, with the full significance of 1 and r square of 63.4%, the t test result shows t (count) is larger than t (table). Hence, it proves that user satisfaction has 63.4%

TABLE 1. Hypothesis results

Hypothesis	Variable	Relationship	b	R^2	f test	t test	Results	Effect
1	System quality ↓ User satisfaction	X_1 ↓ Y	0.071	12.1%	1.791 < 4.67	1.338 < 2.145	H_0 is accepted	No significant partial effect
2	Information quality ↓ User satisfaction	X_2 ↓ Y	0.000	0%	0.000 < 4.67	0.000 < 2.145	H_0 is accepted	No significant partial effect
3	System and information quality ↓ User satisfaction	X_1 & X_2 ↓ Y	0.121, −0.503	20.7%	1.768 and −1.138 < 2.145	1.563 < 3.89	H_0 is accepted	No significant partial effect
4	User satisfaction ↓ Organization impact	X_3 ↓ Y_2	1.000	63.4%	4.747 > 2.145	22.533 ≥ 4.67	H_1 is accepted	Significant partial effect

of significant effect toward organization impact due to the rejected null hypothesis and approved alternative hypothesis.

4.2. **Observation.** The authors have the opportunity to explore PT. Nutricell Pacific's industry and first handedly experience the process of barcode system interactions. The production phases break down into incoming, weighing, mixing and packing. Each phase would require at least two barcode system admin to monitor and operate the barcode software in the PC/computer near the location and scanners are responsible to scan and record stocks, also attaching label into each bag. In particular, each admissions worker has ownership and access in their own station, therefore, avoiding a clashed of ambiguous access and maintaining order. When the product arrived, the incoming team (retriever team) from the logistic department will retrieve the products. Once they confirmed the purchase and delivery order, they will produce a barcode sheet batch and stick a QR code label in each bag. Thus scan each one to record them into their database. For the production module, the "production transforms form" document is produced before production is initiated. The workers will have to examine the products expiration date delivered by the inventory department in order to pass them to the weighing phase. Scanners will scan the goods determined to be mixed or produced into the finished good file. The weighing team will determine the weight of each material needed for production. Then, the mixing teams will then follow the sequential order of the finished good file to mix the macro and micro materials to create the final mixture premix according to the order. In every mixture sequential order, the scanners will scan the materials QR code to proceed to the next material based on the required weight. Once the products mixing is completed, quality control will assess the final product quality before finalizing the product's packing.

4.3. **Questionnaire analysis.** The questionnaire question items are tested through SPSS tool, only 12 items out of 27 are considered valid and reliable for the research findings. Using DeLone and McLean success model, the selected variables contain exemplary measures crucial for the evaluation processes. System quality comprises the elements of easy to use, flexible, system feature, reliability, and response time. Information quality incorporates understandability, accuracy and usability measures. While user satisfaction includes efficiency and effectiveness and organization impact embodies business process change, enhanced coordination and overall productivity. These items are validated with the Pearson validity of 0.520 to 0.813, containing the reliability of Cronbach's Alpha of 0.899. The overall 15 workers agree that the barcode system could retrieve data easier and faster. For the flexibility with the environmental aspects, 8 workers strongly agree while the rest disagree. In the workers' perspective, the workers concurred that the system features of the barcode software fulfill the workers' demand in operation. The reliability of being a robust barcode scanner and long endurance capacity makes 8 to 9 workers agree with this statement. Retrieving data quickly have the total votes of agreement, while the ease of understandability of workers has 5 workers disagree with. As in the effectiveness, most of the workers strongly agree that barcode scanner uses boost production process. Lastly 10 out of 15 workers admit that adjustment to changes is hard and overall workers agree the briefings occurring increase their understanding on barcode system usage.

4.4. **DeLone and McLean evaluation.** System quality and information quality possess strong positive interactivity with usage and user satisfaction. Both components are essential for success measure, especially in an information system. System quality ensures detection of system efficiency and effectiveness measurement as it relates to the user's perceived value of the system quality [16]. Meanwhile, information quality represents input and output in a system set, significantly correlated with user satisfaction in terms of information benefits such as information access, flexibility and quality [4]. Information

TABLE 2. Validated questions

Variable initial	Variable exemplary measure	Questions
SQ1B	Easy to use	Barcode scanner could retrieve data easier and faster
SQ2B	Flexibility	Barcode scanner is applicable in sunny and bright places
SQ3A	System features	Menu to click on to produce label is easy to conduct
SQ3B	System features	Menu to click on to input data can be easily done
SQ3D	System features	Barcode system features fulfil workers' demands
SQ4A	Reliability	Barcode scanner is not easily broken
SQ4B	Reliability	Barcode scanner usage can last more than a day
SQ5B	Response time	Barcode system can retrieve data quickly
IQ1A	Understandability	Barcode system usage is easy to understand
US2C	Effectiveness	Barcode scanner uses boost production process
OI1A	Business process change	Worker faces difficulty in using a barcode system
OI3A	Overall productivity	Barcode system training is held monthly to increase workers' understandability in relevant with their work

quality strongly supports user satisfaction, although if the information quality is not as strong, user satisfaction components have eventually possess the quality of system and information combined. Then, user satisfaction will drive stronger support to organization impact. The lack of system and information quality toward user satisfaction hinted the company to focus on increasing workers' understandability and strengthened information access and understandability. SET perspective highlights the frequent errors which occur, but maintained by the company. Errors are often caused by faulty scanning and new feature updates. Sometimes, it may be the worker's unfamiliarity with the barcode system.

4.5. **Comparison of manual and barcode system.** Three years ago, PT. Nutricell Pacific only applies Zahir program (an accounting software) for internal department usage. When the decision and inspiration to apply barcode system in the production department begin, they bought and developed the SATO software to adapt with their production sequence. It took 2 years in total to finally have it running for manufacturing basis. For two years, the production used the system to connect to dummy database, so it would not distort the real-time data connected with the ERP system called ODOO. The optimized real database has been running for 10 months now and some advantages discovered include faster and more efficient real data updates, rapid data sharing and error identification is much quicker than manual errors. The company uses QR code due to the flexibility and information storage capacity according to the product's requirement. In addition, the data input can be updated into the FTP, hence syncing the database between the ODOO and barcode system. Whenever the workers from any department want to retrieve the data, they can recall them at both Nutricell barcode system and ODOO system. However, the file will be imported or export in the forms of the csv file.

TABLE 3. System comparison

Old system (Manual)	New system (Barcode system)
Count overall stocks and verify stocks count for 2 days	Barcode system keeps record of stocks less than 30 minutes
Human flaws – miscalculation	System verifies and displays data accurately
Excel data in forms of physical record	Retrieve data directly from the system
Benefits: Worker directly interacts with physical documents	Benefits: High perceived easy usage, high interaction ability, high responsiveness, technological sophistication basic knowledge is enough, reduce irritated manual error, assure punctuality
Drawback: Physical document is not permanent, data are not organized, easy data loss, inaccurate real-time data	Drawback: QR burden usability (smartphone must have barcode scanner app to access QR code information), a particular limit
Manual production timing is tantamount to a digital optimized system, but with no precision details for each product bag.	Systematic production timing is tantamount to manual production timing, but with precision and fixed accuracy for each product bag.

5. Conclusions and Recommendation.

5.1. **Conclusion.** The combination of qualitative and quantitative approach based on real data and literature analysis discovers that user satisfaction is a crucial variable which successfully affects the organization impact. While the insignificance of system quality and information quality effect are considered not efficient and effective. The objective evaluation of SET perspective brings forward the good alignment of worker's activity and the barcode system, improvement of increasing product precision and enhanced product quality convinced the "system evaluation" to be efficient and effective. As a valid factor, user satisfaction and the overall processes are efficient and effective. Accordingly, advancements will be required in near future.

5.2. **Recommendation.** The authors suggest several alternatives to consider for further improvement. Firstly, recruit more IT and Research and Development workers and build specialized Quality Assurance team to monitor the system's metrics. Secondly, hold a monthly assessment for frequent briefing and training for acknowledging the workers' understandability progress on barcode system. Thirdly, purchase and own a customized barcode system. By doing so, the company has full authorization of the system development with their own IT workers. Lastly, request an overall ISO audit to provide the company with specific evaluation results for possible hidden technical problems and find solutions to change the task routine for the sake of workers and production process.

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