

General Merchandise Study August 2004

Executive Summary

In August 2004 a technical team from EAN New Zealand (now known as GS1 New Zealand) carried out a study of bar code quality in a major general merchandise outlet.

The bar codes on 956 randomly selected items were tested. This represented approximately 9% of all bar coded inventory items at the test location.

The test used was the full EAN Verification Test. This involves scanning the bar code with an instrument called a verifier that not only scans the symbol but also analyses the pattern of light reflected from it and reports its correctness in terms of physical structure and reflective properties. Additional observations are made by the operator to ensure that the bar code is correct in terms of symbology (type) overall size, height, and location. The number is also examined to ensure that it is an authorised and correctly structured number. Only a bar code that passes each part of the test is said to “pass EAN Verification” and only such bar codes can be relied upon to scan every time a scanner is directed at them.

[The significance of using the EAN Verification Test, is that verification is a mandatory requirement for ranging new products into the grocery trade in Australia and New Zealand. Generally, products that do not pass verification will not be accepted as being fit for sale in grocery retail outlets.]

Two hundred and seventy-five samples (**29%**) passed the full EAN verification test. Six hundred and eighty-one (**71%**) failed it. To put this in perspective, the failure rate for all samples tested by EAN in the ten months preceding this study was 35.8%. EAN tests approximately 1000 samples a month.

5% of the tested samples could not be scanned at all by the test equipment. These would certainly never scan at retail, since the test equipment is capable of scanning some bar codes that ordinary scanners cannot read. Another **2%** had no bar code or number on them. **7%** of the samples therefore could not possibly be scanned. An unknown the proportion of the **71%** that failed the verification test will give some degree of trouble at retail, from complete failure to scan, to difficulty in achieving a scan.

It is important to note that scanners have differing capabilities. A faulty bar code may scan on some scanners but not on others. Any bar code that fails verification is potentially a source of scanning difficulty. Causes of sample failure found in this study are listed below.¹ Each of these faults on its own would result in a ‘fail’ result in an EAN verification test. Depending on their individual nature and extent they may or may not indicate that the bar code will not scan, or will not scan reliably. For a fuller explanation of the significance of each reported parameter, see the full report (attached).

¹ Note that totals do not add to 100% because some bar codes displayed two or more faults

Parameter	No. of cases	%
Insufficient bar height	531	55.5
Failing ISO grade	209	21.9
Decodability	145	15.2
Defects	100	10.5
Modulation	67	7.0
Verifier would not scan	48	5.0
Symbol below min. spec. size ²	42	4.4
Bad location ³	42	4.4
Insufficient light margin/s ⁴	42	4.4
Bar code and number missing	21	2.0
Insufficient contrast	13	1.4
Bar code symbol but no number	7	0.7

The following faults were observed during testing:

Fault	No. of cases	%
Bar code unreadable due to covering of plastic e.g.blister pack	17	1.8
Two GTIN's ⁵ on same product	8	0.8
Bar code around corner	3	0.3
Wrong EAN bar code used (ITF-14) ⁶	2	0.2
Same GTIN on more than one item	2	0.2
Bar code physically damaged	2	0.2
Bar code printed on clear material with no background	2	0.2
Tool wired across card and obscures bar code	1	0.1
Unit consists of a pack of items with individual bar codes but no bar code for the pack	1	0.1

The margin of error for reported results is + 3%

The results demonstrate that the quality of bar codes in the general merchandise sector is significantly poorer than in the marketplace generally, as evidenced by the overall failure rate of 71%, vis a vis the 35.8% rate in EAN's routine testing.

This is consistent with the tenor of comments made by several retail staff at the test location who remarked to the EAN team that scanning difficulties were a routine part of daily work. It is also consistent with the impression the casual observer gains on looking around a typical general merchandise outlet and comparing the bar codes that are seen there with those found at a typical supermarket.

The implications of poor bar code quality are numerous. Scanning delays are the obvious result and are significant to both staff and customer. Errors in data entry will be caused by human error where numbers have to be keyed in, or by incorrect data in the bar codes that

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⁵ Global Trade Item Number – the generic term for EAN identification numbers (colloquially 'bar code numbers')

⁶ Cannot be read by point of sale scanners

may be scanned successfully but which contain incorrect data (for example where the same number appears on different SKU's or where the number on a SKU actually identifies another. Such errors have obvious implications for sales data, inventory management and reordering.

EAN calculates that the grocery trade in New Zealand, even with bar codes that this study shows are twice as good as those in the general merchandise sector, loses two hundred thousand hours of time annually, just in scanning difficulties⁷. The value of this time alone is significant, but there would be unknown subsequent costs in inventory errors and out of stocks.

What to do about these results is a matter for the interested companies.

Doing nothing is an option but would mean that the inefficiencies would remain.

Noting and following up specific examples of scanning difficulty would require the involvement of all sales staff and their supervisors and would set off thousands of individual contacts between retailers and suppliers, if operators reported faults at all. The 2001 study in grocery revealed that 85% of checkout operators never reported faulty bar codes. 15% indicated that they reported them "sometimes." None selected "always" or "often" from the options provided on the questionnaire

Requiring suppliers to submit evidence that the bar codes on their products meet EAN verification requirements (mandatory reporting) is the method chosen by the grocery trade. It involves minimal input by retailers after an initial round of advice to suppliers of the requirement, and briefing of buyers. Thereafter buyers should insist on sighting evidence of bar code compliance when ordering new product, and periodically when reordering current stock, to ensure continued compliance.

Evidence is readily available, in the form of reports produced by EAN when suppliers send samples to them for testing. These can be supplied electronically or in hard copy. Suppliers that elect to become EAN Accredited companies are exempted from the reporting requirement, since they must routinely carry out EAN verification on the bar codes on their own products as a requirement of the accreditation. Accredited companies are allocated a distinctive number that they quote in correspondence to buyers, indicating their exemption. Non-accredited suppliers send samples to EAN for testing.

The costs of compliance are not borne by retailers therefore, but equitably by suppliers in relation to the number of SKU's they supply. Where a bar code does not achieve a 'pass' on the EAN Verification test the reasons for the failure are discussed between the suppliers and EAN. Where the failure is unlikely to affect actual scanning performance, the buyer has the discretion to accept the product regardless. Where scanning difficulties are a real

⁷ EAN NZ study of retail bar codes in grocery May 2001. The results of this study were consistent with another conducted by Progressive Enterprises over the same period. Foodstuffs (Auckland) examined the quality of bar codes on cartons passing through their Distribution Centre in September 2001 and obtained results that were consistent with both retail studies.

possibility EAN will have provided the supplier with any necessary advice and assistance to achieve improvement without buyers even being aware of the situation.

The 2001 study of grocery bar code quality has not been repeated on the same scale but a smaller study conducted in August 2003 suggests that the rate of scanning difficulties of grocery bar codes has halved over the two years following the introduction of quality reporting requirements.

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Report

A need to study bar code quality in sectors other than grocery to clarify the extent to which grocery experience can be generalised into other sectors was recognised.

The general merchandise (aka hardware) sector was identified as being suitable for study.

The managements of all of the major general merchandise retail chains had indicated an interest in learning the nature and extent of bar code quality problems in their sector.

The Head Office and Manager of a large Wellington general merchandise retail outlet carrying thirteen and a half thousand SKU's agreed to allow a study to be carried out in that store.

Two EAN technical staff and (a planned) four helpers from Student Job Search were dedicated to a study that was originally set down for 17 August 2004. In the event the non-appearance of one student helper and interruptions due to bad weather damaging the site meant that the study took place over two days, 17 and 23 August.

Purpose of Study

The aim of the study was to carry out EAN verification testing on a least one thousand randomly selected general merchandise retail items' bar codes, although the hope was that 1,350 could be tested, to represent approximately ten per cent of the inventory held at the test site.

Method

Two testing stations were established in an office off the showroom at the test site.

The Student Job Search helpers walked specified routes through the showroom and the nearby Building Supplies building picking samples for testing and placing them in trolleys, taking them to the test location each time a batch of thirty samples had been collected.

Each helper started in a different corner of the showroom with instructions to walk to the diagonally opposite corner by a route that would take them along every display in the store.

One corner was not used as a start point by a helper because of the non-appearance of one of them but an EAN staff member working alone on the afternoon of the second day of testing started in the corner that had been assigned to the absent helper, using the picking sequence that helper would have used.

One helper started in the Building Supplies building, picking from the two small areas in that building that contained items bearing bar codes.

Random selection was achieved by a pattern of picking an item every fourth pace, picking alternately from the right and left in the sequence high - waist level – low from the displays at each point.

If the item at a pick point was of such a nature that it was the only thing available for picking – such as a curtain rod standing upright and occupying the whole available height range – it was picked as though it had been at the “high – waist – low” level due for picking at that point and the sequence was continued uninterrupted.

Where there was nothing at a pick point, such as a blank wall or open space, the pick was assumed to have taken place and the picker moved on to the next point in the sequence.

Where an item was too heavy to transport its identity and location were noted and a tester with test equipment mounted on a trolley went to the item and tested it *in situ*. Because the equipment is not designed to be portable this method was cumbersome and unsuitable for use over the whole study.

If an item was one whose nature precluded the use of a retail bar code – such as a length of downpipe – and bar codes were not routinely used on it, it was excluded from the study and neither recorded nor examined.

The distance between picks was based on an assessment of the number of paces required to walk the length of every display in the store, divided by the number of helpers and the number of samples sought. The non-appearance of one helper and the interruptions to the study were not helpful in maintaining the planned pattern but it is believed that random selection was achieved nonetheless. Duplication was prevented by visual monitoring of samples as they were delivered for testing and by manual checking of results sheets subsequently.

Samples were fully EAN-tested and the results recorded on Results Sheets against the description and GTIN of each product.

Student Job Search helpers assisted as clerks entering results on sheets at the dictation of the tester.

The helpers who had delivered items for testing returned the items to the shelves from which they had come and then gathered another batch of samples.

This cycle was planned to continue until the site closed for the day or until 1,300 items had been tested. In the event that less than one thousand items had been tested on the day of the study, which was the situation at the end of the first day, the study was to continue the following day, with the same timings, until the minimum number of tests had been completed. Weather damage to the test site prevented work the next day and a second day of testing was eventually achieved five days later.

Results

Nine hundred and eighty-eight samples were selected.

Of these, six were excluded as being inappropriate choices by the picker such as sheets of roofing material that would not normally be bar coded. Thirty-six sampled items bore only the retailers' SKU number encoded in Code 128 bar codes. These are not normal retail bar codes but they could be scanned at checkouts on the study site. Because EAN numbers and bar codes did not identify them they were excluded from the study, leaving nine hundred and fifty-six samples to be EAN-tested.⁸

The number of samples analysed therefore was nine hundred and fifty-six, representing approximately 7% of total inventory. Since an unmeasured proportion of inventory – approximately one fifth – at the test location is not bar coded the samples actually represent a higher proportion of bar coded products. Excluding non-bar coded inventory therefore, the samples represent about 9% of inventory.

Two hundred and seventy-five samples (29% of EAN-marked samples)⁹ passed the full EAN verification test. Six hundred and eighty-one (71%) failed it.

To put this in perspective, the failure rate for all samples tested by EAN since 1 November 2003 has been 35.8%, almost exactly half the rate disclosed in this study. EAN tests approximately one thousand samples a month.

Causes of sample failure found in this study are listed below. Note that totals do not add to 100% because some bar codes displayed two or more faults. Each of these faults on its own would result in a 'fail' result in an EAN verification test. Depending on their individual nature and extent they may or may not indicate that the bar code will not scan, or will not scan reliably.

Parameter	No. of cases	%
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⁸ For the information of the host company EAN staff verified the bar codes, although they were not EAN symbols. Of the thirty-six Code 128 symbols encountered in the study ten (28%) failed to meet the ISO verification grade considered the minimum for EAN symbols. In the absence of an industry standard for Code 128 no comment can be made on whether this represents a 'pass' or 'fail' result.

⁹ All references to percentages of samples hereafter refer to percentage of EAN-labelled samples.

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Margin of Error

The margin of error for reported results is $\pm 3\%$

Discussion

'Verification' refers to the use of the instrument called a verifier. In simple terms a verifier is a sophisticated scanning device that not only reads a bar code but also carries out a detailed analysis of the behaviour of scanner light reflected off the symbol, analysing it in terms of the 'view' it provides to scanners attempting to read the symbol. A 'pass' on the verifier is a grade defined by ISO as indicating that a bar code conforms to the dimensional specification for its symbology (type) and that it has reflective properties sufficient to provide a clear view of itself to a scanner. It is not *on its own* evidence that the bar code will scan reliably.

'EAN Verification' is a series of tests and observations that include using a verifier but that also involve measuring the overall dimensions of the symbol, ensuring that it contains the same number as is written below it, checking that it is in a position where a scanner can 'see' it without extraordinary efforts by the operator, and ensuring that it is the right sort of bar code for use in the situation involved.

(Note that scanners do not all perform the same and the fact that a bar code scans on one or more scanners is no evidence that it will scan on others).

Because 'verification' does not test all of these parameters it is possible for a bar code that achieves a nominal 'pass' on a verifier to still not scan. Only a pass in an 'EAN Verification' test offers certainty that a bar code will scan every time.

The bar codes sampled in this study were all 'EAN verified' i.e. subjected to the full range of visual and technical tests.

55.5% of samples had insufficient bar height.

¹³ Cannot be read by point of sale scanners

Bar height is important in the retail environment because the omni-directional, or 'presentation' scanners used in supermarkets and service stations direct a pattern of beams outwards and a bar code that does not have the correct height/width ratio may not be read as soon as it enters the pattern of beams because the beams, being on various angles, may not immediately cross it in such a way as to intersect the whole width of the symbol. Some users of hand-held scanners argue that this is not an issue for them because they can see the single line of light projected by their scanners and they can direct the beam across a shortened symbol.

This is debatable. The shorter a symbol is, the longer it will take an operator to align it with the beam and position the beam along it, and if the symbol is very short, the harder it may be for the operator to hold the beam along the symbol. Additional time taken to scan because of these issues may well slow the process as much as first-pass scanning 'misses' delay supermarket scanning.

These results indicate a significant potential for scanning delays due to truncated (shortened) symbols. The extent of any delay will be influenced by the extent of any truncation and this study did not separate 'slightly' truncated symbols from 'severely' truncated ones. Some symbols less than ten millimetres in height were observed (e.g. *Fortress* screws in jars).

21.9% of samples failed to achieve a 'passing' ISO grade when verified. The required minimum grade is 1.5 on a four-point scale. Failing results during this study varied from 1.4 (a failure so marginal that the sample may have passed had the test been repeated) to 0.0. Since it is impossible to say where the dividing line between "will scan/won't scan" lies because of the number of variables involved, a breakdown within the 'failures' would serve no purpose.

Failure to achieve a passing grade does not automatically indicate that the symbol cannot be scanned but it indicates some degree of danger that scanning difficulty will occur.

15.2% of samples failed on decodability.

'Decodability' is a test in which the verifier compares each character in a bar code individually against a theoretical 'perfect' example in terms of dimensional relationships and reflective properties. A bar code that fails for decodability contains at least one character that conforms to the ideal so poorly that the verifier cannot be confident that ordinary scanners will recognise the character and that they may therefore be unable to decode the bar code.

10.5% of samples failed for defects.

'Defects' are, as the name suggests, faults in the bar code itself, either light patches in what should be dark parts, or marks and smudges on what should be light parts. The significance of these marks and voids is that a danger exists of scanners perceiving dark spots on light spaces as being bars, or voids in dark print looking like spaces. If a verifier fails a sample for a defect it is because the defect is large enough to create this possibility and therefore the possibility that the bar code will not scan.

7.0% of samples failed for modulation.

'Modulation' refers to the ability of the verifier – and therefore of any ordinary scanner – to clearly see each bar and space in a bar code. If a verifier fails a sample for modulation it

means that at least one bar or space is insufficiently clear for the verifier to be confident that all ordinary scanners will see it. This could be due to various factors including insufficient width, defects, or reflective properties causing 'blurring' of reflected scanner light.

The verifier could not scan 5.0% of samples.

A verifier may scan bar codes that an ordinary scanner will not, but if a bar code is so bad that a verifier cannot read it no scanner will be able to do so.

4.4% of samples were below the minimum specified size.

The smaller a bar code is, the greater the danger that its bars and spaces will run together in the scanner's view so that it is unreadable, or that the spot of scanner light will traverse all of a narrow bar and parts of the space either side of it (or vice versa), making the character unrecognisable. It is also often the case that, because of the high print tolerances required in bar codes, small bar codes are not produced to a good quality that provides a crisp print with clear edges and good contrast.

4.4% of samples were in bad locations.

Because operators can correct for location with a simple wrist movement when scanning, EAN tests for location on retail items tend to be very liberal, despite the existence of location guidelines within the EAN Standard. Bar code samples will be failed for location only where they are in positions that are positively awkward for operators, or where scanning is seriously compromised, such as because the symbol physically obscured or distorted. In this study for example eighteen items representing 1.9% of all samples tested, had bar codes that were unreadable because they were under blister packs, obscured by plastic packaging, or covered by the items packaged against them, and three more had bar codes that went around corners on the packaging.

4.4% of samples had insufficient light margins.

Bar codes need a certain amount of clear space, known as 'quiet zone' or 'light margin' either side of them. Insufficient light margins will usually mean that a bar code will not scan at all, although in cases of minor insufficiency bar codes may scan on some scanners but not others.

2.0% of samples had no bar code and no number.

Items that would not be expected to have bar codes on them, such as lengths of downpipe or sheets of roofing material, were excluded from the study. This result applies to retail items on display in the showroom and indicates the presence of potentially up to two hundred retail items with no bar code that operators can scan, and no number that they could manually enter at the checkout.

1.4% of samples failed for print contrast.

This indicates the presence of bar codes in which either the background is too dark or the bars are too light, so that scanners cannot tell bars from background and, depending on the extent of the insufficiency, may not be able to scan the symbol. The usual cause of poor contrast is inappropriate background colour such as the gold in one sample, although poor bar colour or inadequate inking of the bars may also be responsible. Two samples encountered in this study had bar codes printed straight on to clear plastic so there was no background at all, and no scanner light could be reflected back from any part of the symbols.

1.2% of samples had numbering errors.

- ❑ Eight items were found that had more than one GTIN and bar code on them.
- ❑ Two items were found sharing the same GTIN.
- ❑ One item, a pack of twelve light bulbs, had no GTIN but twelve individual bulbs' bar codes were visible through the wrapping.

When these items were scanned at checkout the record of the sale that would be created would depend entirely on which bar code/s the operator chose to scan. If as in the case of the light bulbs in this study the retailer chose to use the individual items' GTIN to identify the dozen pack the danger is created of a customer opening a pack or taking one bulb from a damaged pack and then being charged for twelve at the checkout, with the sale of twelve items being mistakenly recorded by the POS system.

0.7% of samples had a bar code with no number printed beneath.

In these cases if the symbol fails to scan at checkout the operator has no means of discovering a number to manually enter.

0.2% of samples had the wrong bar code symbology (type) on them.

These items had fourteen-digit GTIN's and ITF-14 bar codes on them, printed at an impossibly small size in order to fit on a retail item. Fourteen-digit numbers are for use in distribution, not retail, and retail scanners cannot read ITF-14 bar code. Because of the extreme miniaturisation of the bar codes on the samples in this instance, no scanner could have read them.

Conclusion

The quality of bar codes in the general merchandise sector is demonstrably poorer than in the marketplace generally, as evidenced by the overall failure rate of 71%, vis a vis the 35.8% rate in EAN's routine testing.

This is consistent with the tenor of comments made by several retail staff at the test location who remarked to the EAN team that scanning difficulties were a routine part of the daily work. It is also consistent with the impression the casual observer gains on looking around a typical general merchandise outlet and comparing the bar codes that are seen there with those found at a typical supermarket.

The implications of poor bar code quality are numerous. Scanning delays are the obvious result and are significant to both staff and customer. Errors in data entry will be caused by human error where numbers have to be keyed in, or by incorrect data in the bar codes that may be scanned successfully but which contain incorrect data (for example where the same number appears on different SKU's or where the number on a SKU actually identifies another. Such errors have obvious implications for sales data, inventory management and reordering.

Putting a cost on inefficiencies caused by bar code faults is problematic since so much information is unknown and so many assumptions have to be made. EAN calculates that the grocery trade in New Zealand, even with bar codes that this study shows are twice as good as those in the general merchandise sector, loses two hundred thousand hours of

time annually, just in scanning difficulties. The value of this time alone is significant, but there would be unknown subsequent costs in inventory errors and out of stocks.

What to do about these results is a matter for the interested companies.

Doing nothing is an option but would mean that the inefficiencies would remain.

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