

$$f'(h) = -\frac{3\pi h^2}{4} + 15\pi$$
$$f'(h) = 0 \Leftrightarrow h = 2\sqrt{5}$$

max: $f(2\sqrt{5})$



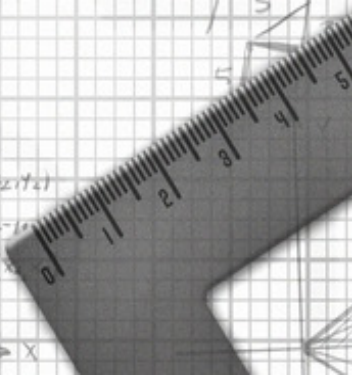
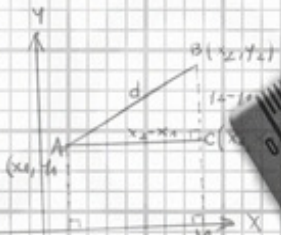
Business by numbers:

Mastering data and analytics

$$60 - \frac{h^2}{4}$$
$$+ 15\pi h$$
$$\frac{h^3}{4} + 15\pi h$$
$$\sqrt{5} \sqrt{h} = -2\sqrt{5}$$

$$\int \sqrt{x^2 + a^2} dx = \frac{x}{2} \sqrt{x^2 + a^2} + \frac{a^2}{2} \ln|x + \sqrt{x^2 + a^2}| + C$$

$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln|x + \sqrt{x^2 + a^2}| + C$$



CONTENTS

Business by numbers: Mastering data and analytics	3
Business intelligence	5
Business analytics	8
What is big data?	9
Can small businesses tap into big data?	10
Collecting customer data	13
Data security and legal issues	15
Conclusion	18
Sources	19
Picture Locations	20

Business by Numbers: Mastering data and analytics

Numbers might not make the world go round but they can be used to describe the forces that do. Pythagoras believed that “number rules the universe” and data can certainly be hugely important and valuable for businesses of all shapes and sizes.

Most businesses create, deal with, or are exposed to many different pieces and types of data every day. Transactions, customer details, and receipts and expenditures of varying kinds all add to the never-ending flow of information that surround and in some ways define a business.

In the days before every business had access to the Internet and huge amounts of processing power, what would now be thought of as ‘data sets’ might have been restricted to things like client lists and financial and transactional records.

Now that trickle has become a flood. Wal-Mart already captures more than 2.5 petabytes (2.5 quadrillion bytes, which is a 16-digit figure) of data from customer transactions every single hour. ²

If that was all recorded on paper, it would mean Wal-Mart was filling 20 million four-drawer filing cabinets per hour. Most US companies now store more information than the Library of Congress (the de facto national library of the United States of America).

The mere presence of all this data isn’t too useful in itself. If you don’t know what you’re looking for or how to sift all this accumulated information then it can become the data equivalent of white noise and a little overwhelming. But if you do then the benefits can be huge.

A McKinsey Global Institute Study looked at big data in five major domains – healthcare in the USA, the public sector in Europe, retail in the USA, and manufacturing and personal-location data globally. ³

It found that:

“A retailer using big data to the full could increase its operating margin by more than 60%. Harnessing big data in the public sector has enormous potential, too. If US healthcare were to use big data creatively and effectively to drive efficiency and quality, the sector could create more than \$300 billion in value every year. Two-thirds of that would be in the form of reducing US healthcare expenditure by about 8%. In the developed economies of Europe, government administrators could save more than 100 billion (\$149 billion) in operational efficiency improvements alone by using big data, not including using big data to reduce fraud and errors and boost the collection of tax revenues. And users of services enabled by personal-location data could capture \$600 billion in consumer surplus.”

You don't have to be an operation dealing with Wal-Mart's 245 million customers a week⁴ to be able to benefit from data and analytics however. Small businesses can also tap into big data and the value held in other individual datasets.

Business intelligence

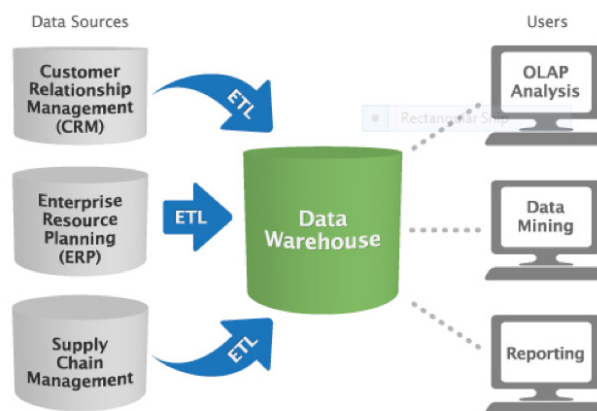
Analytics involve the identification and analysis of meaningful patterns in data. In business terms, it can be defined as the process of transforming data into insight with the aim of making better informed decisions.

Business analytics is also closely related to the concept of business intelligence. Where business analytics is concerned with the analysis, interpretations and search for patterns within the data that a business has collected or has access to then business intelligence can be seen as the tools, systems and processes used to gather, store and organise that data.

Most companies collect and collate data from multiple sources. A data warehouse can be used to consolidate data from these different sources. This data can then be queried and analysed.

If a company wanted to determine the profitability of a new line in a given quarter, for example, it would need to pull streams of data from various sources. This could include manufacturing cost information from enterprise resource planning (ERP) software, distribution and transportation costs from a supply chain management system and marketing campaign costs from the associated marketing software.

This can then be set against revenue data from the appropriate accounting system.



PIC 1

The relevant data from the various sources is aggregated and organised within the data warehouse and the user can then make queries of the 'data marts'. These are small slices of the data warehouse that are generally oriented towards specific lines, teams or areas. They serve as the access layer for the data warehouse as a whole.

A data warehouse requires ETL (Extract, Transform and Load) tools that are used to:

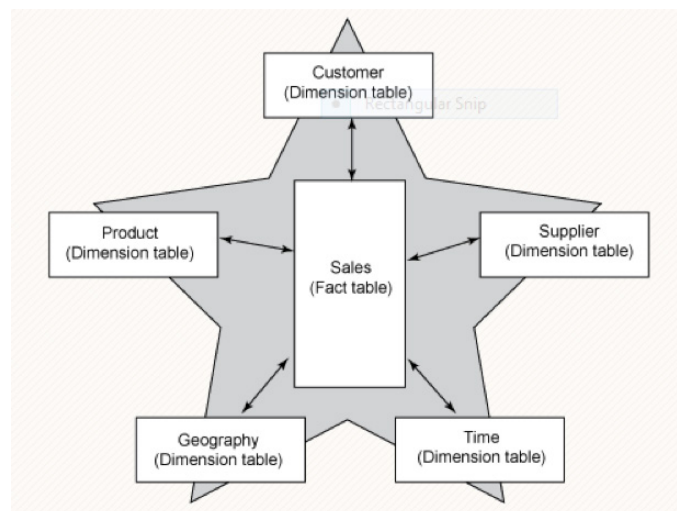
- Extract data from other databases and systems such as customer relationship manager (CRM) applications
- Transform the data into a common format along with data from other sources
- Load the data into the data warehouse for analysis

Many data management packages these days are supplied with ETL tools, but they can also be purchased and used as additional bolt-ons.

The ETL processes represent the 'back end' of data warehousing, essentially getting the relevant data together. The 'front end' is usually achieved by online analytical processing or OLAP tools and will involve elements such as querying the data warehouse and presenting information in some sort of usable fashion. This is where the related areas of business intelligence and business analytics really start to approach each other fast.

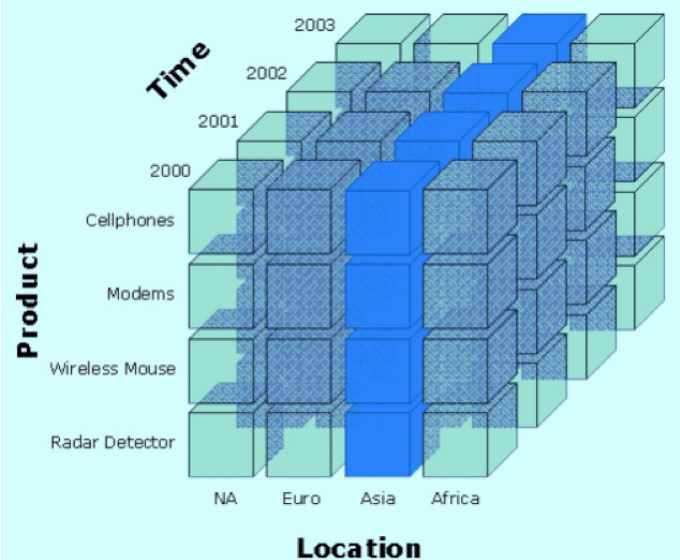
The information accessed through OLAP can be expressed in different ways. These can involve 2D star or snowflake 'schema' with a fact table containing business data such as unit sales and sale values in the centre.

Radiating out from this there will generally be a number of 'dimension tables' including associated information such as customer details, time and location.



PIC 2

OLAP systems can also express information in the form of 'cubes' (although this terminology can be confusing when you start working in more than three dimensions). Essentially, the cube is made up of cells that each contain the specific information sets from a schema arranged in different dimensions. They could, for example, take data about products, sales, and costs and add them up by month, year, store, market or any other combination.



PIC 3

Business analytics

Business intelligence typically asks questions like ‘What happened?’, ‘What sold?’, ‘For how much?’, ‘Who to?’, ‘When?’ and ‘Where?’

Business analytics goes a step further, taking the answers to those questions and using them to ask more searching questions like ‘Why did it happen?’, ‘Can we improve sales by tweaking here?’ and ‘What will happen if we change a factor there?’ Data analytics might even throw up new questions you’d never even thought to ask before.

Data analytics also provide more of a rational, evidence-based direction for businesses to take rather than relying on the hunches or gut instinct of key decision-makers. This doesn’t mean that instinctive decisions must be entirely done away with however, but they can be better informed and even tested using data-based models before being implemented in the real world.

Some common uses for business analytics include:

- Data mining: exploring data to look for new patterns and relationships
- Quantitative analysis: attempting to explain why a certain result happened
- A/B or multivariate testing: seeing what will happen when one or more variables are changed
- Predictive analytics: forecasting future results

Data mining involves sifting through data to look for hidden or previously unknown or unproven patterns. Data mining software uses advanced pattern recognition algorithms to trawl through large amounts of data looking for these hidden patterns. These patterns could reveal that certain products sell better at certain times of the year in certain places or that customers who viewed or purchased one item were likely to be interested in another specific item.

If you’ve ever shopped on Amazon and seen the sections like ‘Customers who bought this item also bought...’ or ‘Related to items you’ve viewed...’ then you’ve already seen one of the most impressive consumer-based pieces of data mining out there.

Amazon has access to more customer data than most of course. Some claim it has too much but in purely business terms it has used the data it’s collected masterfully.

What is big data?

Data has become increasingly cheap and easy to store. Add the increasing ability to analyse huge amounts of raw data in order to find something valuable and you can see why so many companies are so keen on acquiring and hoarding it.

According to IBM, 90% of the data that currently exists in the world has been created over the last two years.⁵ Every time you make a purchase, use a credit card, view a product online or share or like a company's social media page, you're adding to that growing mountain of data and companies aren't just hoarding their customers' data.

There is also information about products, materials, shipping and marketing costs and all the other individual factors that go into finally bringing a customer and a product or service together. These vast amounts of data, that would be impossible to sort through with a human eye (or even using software until quite recently) is essentially what big data is.

Big data has been a buzzword for a while now of course, right up there with the Internet of Things (IoT). It's only now starting to be used effectively however.

TechTarget Inc.'s 2015 IT Priorities Survey found that 31% of more than 2,000 respondents worldwide were planning deployments of BI, analytics and data warehouse software in 2015. That figure had actually fallen from 41% in 2014 while investments in big data analytics and big data processing and management had risen to 25% and 21% respectively. Neither area had even warranted its own response category last year.⁶

"Everyone has plenty of data at this point. Now it's about using it," said Cam Fortin, Senior Director of Product Development at Wine.com Inc. – an online wine retailer based in San Francisco.

Chief Data Officer at Ohio based Nationwide Mutual Insurance Co., Wes Hunt, agreed while noting his company was looking at incorporating data from more than just online transactions, such as call centre notes and machine data from server log files.

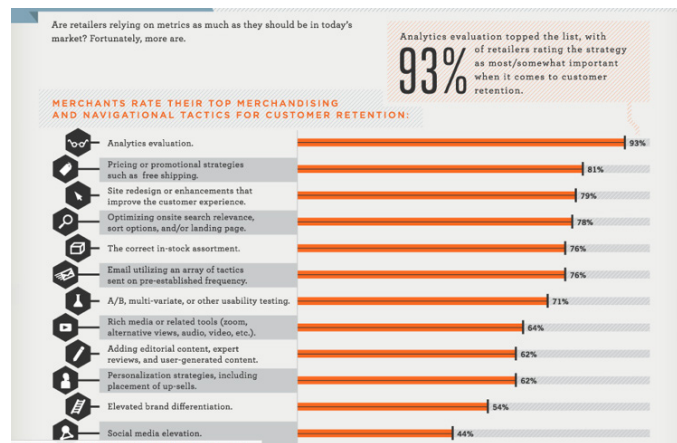
"We're looking at the big data space," he said. "We've been working on that, and it's starting to grow and more use cases are becoming apparent."

Can small businesses tap into big data?

Where big data is concerned, being a big business can help. Successful business analytics depends on skilled analysts who understand the technologies and on software and systems that allow them to do so.

Just 3.4 % of CMOs surveyed by McKinsey in 2013 believe they currently have the right talent to fully leverage marketing analytics and 98.8% describe finding that talent as “challenging.”

Effective analytics can be hugely important to small businesses however. In a survey by Baynote, analytics came top if the list when online retailers were asked to rate the most important strategy for customer retention with a massive 93% of respondents listing it as the top tactic.



PIC 4

Online retailers do perhaps have an advantage in collecting and analysing data, as pretty much every aspect of their business produces it and tools such as Google Analytics offer tiered services, with free services available to all and stepped payments on offer for added functionality.

It's also relatively easy to tweak an online business using online data for A/B testing. Essentially this involves running your current website as it is alongside a version that has one or more variations.

Half of your visitors are redirected to the altered or test site and you basically track their journey through the site and compare conversion rates.

What you change is up to you but it could include:

- Headlines
- Written content
- Testimonials
- Images and colours
- Call to action buttons and texts

More advanced testing that goes beyond the design of your website and could also apply to offline businesses and include price structures, promotions and delivery charges.

Dave Bailey, Chief Executive of fast-growing digital games company Mediatonic, told the BBC that big data is “fundamental to our business and really important for many small-to-medium sized companies. It directs our strategy.”

He went on to explain that understanding gamer behaviour was crucial in an industry that has moved largely to a free download model, where revenues come mostly from in-game purchases and half of players never return:

“We can test different versions of a game on different demographics at the same time and tweak them in response to the real-time data we receive. We can now understand each individual player.”

Again it helps that Mediatronic is operating in the digital realm but more traditional businesses can also tap into big data. Even if they do not collect the bulk of the data they use, they can buy into information collected and sorted by third parties.

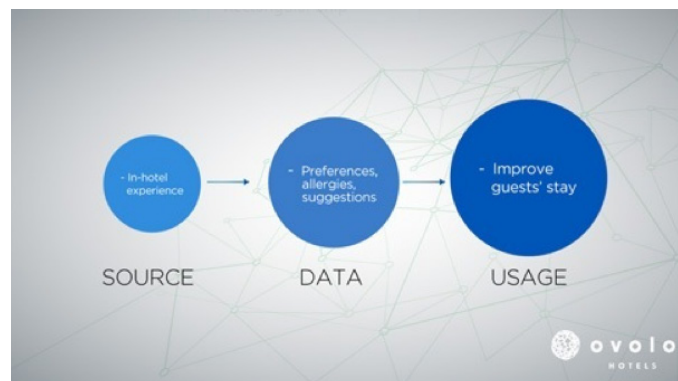
A. Jennings, Chief Data Analytics Officer at San Jose-based FICO, a global data analytics company, says that “for sole traders it’s not realistic to expect big data to apply to them directly, but they can access services that rely on big data analytics, such as maps and weather forecasts.”

A family-owned US realtors called Twiddy & Company manages almost a thousand holiday homes for rent in the 200-mile-long string of North Carolina islands known as the Outer Banks. Like many businesses, Twiddy had amassed years’ worth of data that was all hidden in spreadsheets.

They used SAS' business analytics tools to distil all these spreadsheets into more manageable formats and was able to offer pricing recommendations on the basis of the week, prevailing market conditions, seasonal trends, and the size and location of a home amongst other criteria.

Since it began to do so, overall bookings increased and more homeowners started to recommend Twiddy as a property manager. Their property management portfolio has also increased more than 10% over the past three years.¹⁰

A case study of Ovolo Hotels, a family-owned company with several boutique hotels in Hong Kong and Australia, decided to narrow its data acquisition to only the answers to the questions it wanted to ask. It gathered information via various sources, including social media, its website and questionnaires provided during the stay.



PIC 5

On the basis of the data it gathered, the company made a number of key changes including:

- Flexible check-out: one of the top items on customers' wish lists
- Free breakfasts, drinks and snacks: one of the best ways to increase customer satisfaction
- Social happy hour: business and other travellers landing in a strange city often feel somewhat isolated. Ovolo built on comments to institute a Social Happy Hour where guests can mingle over free drinks
- Apple TV: Ovolo found this was the best way to integrate TV and allow the majority of their customers to synchronise their own playlists, apps and music.¹¹

Collecting customer data

SMEs certainly won't generate their own data to the same extent as giants such as Wal-Mart and Amazon but all businesses generate data of some sort and almost all data can be useful. Talking to Forbes, Ronald D. Williams – the President & CEO of Texas-based data management firm Business Evolution (BE) – made the following points regarding SMEs and data:

1. All businesses collect data. Either from the cash register, casual conversations with customers, incentive programs, trend analysis of financials or historical experience monitoring behaviour
2. All data is good data and all businesses have data, they just need to recognize it as such
3. Data levels the playing field for all companies but a Data Strategy is needed to be competitive
4. If businesses are clear about what they want from their data then the data can be more than helpful – it can be meaningful ¹²

Businesses of any size can buy into third party big data sets but the value of these can be limited if they do not have a direct relevance to the business. Huge big data sets can also be difficult or impossible to make sense of without the requisite expertise or software systems in place.

One of the most important sources of data for any business will always come from the customers themselves. They, after all, are what your business should revolve around. This is often referred to as primary or local data and can be collected via methods such as focus groups and surveys.

PIC 6

All information can be valuable but the amount you can reasonably ask for will often vary depending on the situation. If you are physically surveying shoppers in a town centre you might be able to keep their attention for several minutes – as long as you give them an idea of how long it will take beforehand. You may also be able to tempt some customers to fill in longer forms by offering incentives such as vouchers against their next purchase or entry into a prize draw.

In general however, online forms should be short and snappy. Consumers are bombarded with requests on their attention and time and your customers are visiting your website, store or premises to make a purchase or engage a service, not because they enjoy filling out forms.

It's often best to narrow your efforts, choosing a specific objective for each survey and changing the survey questions once you have gathered enough responses to be useful. Open-ended questions such as 'How did you feel about the product?' can be useful in giving customers free reign in their feedback.

You may learn some interesting things but they can also be difficult to process, especially when dealing with responses in bulk. 'Yes/No', multiple choice or 'On a scale of 1 to 10...' type questions are more easily translated into usable data. Some data mining software can trawl open responses for indicators however, searching for certain words or phrases that indicate positive or negative sentiment.

While you're gathering data from your customers, collect as much demographic information as you can. Names and email addresses can be useful for a mailing list (only include customers on a list if they actively opt-in however) but details about gender, age, income and lifestyle can give you a clearer idea of who is buying what from you.

Data security and legal issues

In the UK the main piece of legislation that covers the collection, storage and use of data is the Data Protection Act.

The Information Commissioner's Office (ICO) says that under the Act you should:

- Only collect information that you need for a specific purpose
- Keep it secure
- Ensure it is relevant and up to date
- Only hold as much as you need, and only for as long as you need it
- Allow the subject of the information to see it upon request¹³

The ICO also has guidelines for SMEs collecting customers' personal information. This includes advice such as:

- Decide whether customers would already know who you are and what you are going to do with their information, including disclosing it to a third party. If not, draft a privacy notice for them
- Make sure your privacy notice is clear, honest and will be understood by the people it is aimed at. Avoid confusing mixtures of 'opt-ins' and 'opt-outs'. Do not pre-tick consent boxes
- If you are going to give your customers a choice, for example over the disclosure of their details to another business, explain the choice clearly and respect their wishes
- Make sure customers know the difference between information they need to provide to get the goods or services they've requested, and information which is optional¹⁴

You will also need to comply with the relevant passages of the Data Protection Act if you buy or sell databases containing customers' personal information. If you use the data you've gathered to engage in direct marketing such as email shots you will also have to be aware of the Privacy and Electronics Communications Regulations.

Some of the issues you should be aware of include requiring specific consent (generally through a tick box opt-in) for emails and texts and providing details for opting out of future messages. Telephone marketing should always be screened against the Telephone Preference Service (TPS) database.

At-a-glance guide to the marketing rules

Method of communication	Individual consumers (plus sole traders and partnerships)	Business-to-business (companies and corporate bodies)
Live calls	<ul style="list-style-type: none"> Screen against the TPS Can opt out 	<ul style="list-style-type: none"> Screen against the Corporate TPS Can opt out
Recorded calls	<ul style="list-style-type: none"> Need specific consent 	<ul style="list-style-type: none"> Need specific consent
Emails or texts	<ul style="list-style-type: none"> Need specific consent Or soft opt-in (previous customer, our own similar product, had a chance to opt out) 	<ul style="list-style-type: none"> Can email or text corporate bodies Good practice to offer opt out Individual employees can opt out
Faxes	<ul style="list-style-type: none"> Need specific consent 	<ul style="list-style-type: none"> Screen against the Fax Preference Service (FPS) Can opt out
Mail	<ul style="list-style-type: none"> Name and address obtained fairly Can opt out 	<ul style="list-style-type: none"> Can mail corporate bodies Individual employees can opt out

This only gives a very broad overview of the marketing rules. For detailed advice, [see our full guidance on direct marketing](#).



Version 1
September 2013

PIC 7

The seventh data protection principle in The Data Protection Act states that “appropriate technical and organisational measures shall be taken against unauthorised or unlawful processing of personal data and against accidental loss or destruction of, or damage to, personal data”.¹⁵

What does the phrase “appropriate measures” actually mean though? There have been some spectacularly high profile data losses and security breaches in recent years and if the likes of Orange, Sony and even Google can’t keep data completely safe, what chance has an SME?

The good news is that the most sophisticated hackers are more likely to expend their energy on multinationals with vast data reservoirs than the mailing list of a small business. Any company can be the victim of cybercrime however and not all data losses are due to malicious hackers. The North Carolina Department of Health and Human Services, for example, blamed a computer programming error for the mailing of nearly 50,000 children’s Medicaid cards to the wrong addresses.¹⁶ This is why “organisational measures” are also specified alongside technical ones in the Data Protection Act.

The ICO suggests that, with no single product or measure being 100% effective, SMEs that hold personal data should adopt a layered approach to security.

Areas you should think about include:

- Physical security

Protect against equipment containing sensitive information being physically stolen in a break-in. Provide extra security for servers and don't leave storage or back-up devices unsecured.

- Anti-malware

Install extensive anti-virus and anti-malware software and, crucially, keep it up to date.

- Intrusion defence

Keep firewalls active and updated. Penetration tests can find weaknesses in your system by simulating a hostile attack.

- Restrict access

Only those who genuinely need to should have access to the data. Each individual should have their own username and a strong password. Alarmingly, the most popular passwords continue to be '123456' and 'PASSWORD'.¹⁷

- Training and policies

Institute security policies and ensure all staff are trained in following them.

- Segmentation

Consider separating or limiting access between network components such as your web server and main file server. This means that if your website was compromised, the attacker would not have access to your central data core.

Conclusion

As is often the case with new developments, especially of the buzzword variety, everyone wants to get their slice even if not many seem to know exactly what that will entail.

Business analytics has been with us for a long time and has a proven track record but expanding into the seas of big data remains a challenge. There are however many examples already of companies making good use of big data and that list is only due to get longer.

According to a report by the Direct Marketing Association (DMA), marketers are set to spend an estimated \$11.5 billion (£7.24 billion) on data and related solutions across the top three direct marketing platforms of email, direct mail and display advertising.¹⁸

Direct marketing is only one potential use for big data and analytics. Statistics and data can certainly help you target your marketing. Rather than the relatively expensive scattershot approach of 'send your message and see who replies', marketing has increasingly moved towards a more tightly focused model, achieving a higher conversion rate and hopefully annoying fewer existing or potential new customers in the process.

Data is still being produced at an astounding rate. The big data landscape is certain to keep evolving, as businesses work out the best way to leverage it while issues of privacy and ethics continue to be debated.

Big data is not just for the big players however and SMEs should keep their eyes on new developments. Anything that can give a smaller business an edge can be vital and the potential benefits of big data could be huge.

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