6 Business and Finance

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Abstract

What is the goal of a business? Is it even a good question to ask? Even the smallest companies have mission and vision. Whether it is in the head of the sole owner of small entrepreneur or is it stated in the strategic documents of the large global company, there always is the answer to the questions "Why are we here?" and "What we want to achieve in future?". These questions are the same as the famous "Where Do We Come From? What Are We? Where Are We Going?" None of these questions is related to making money. However, if the mission and vision are to be sustainable, the enterprise definitely cannot lose money while working on the mission and vision. The goal is to achieve the mission and vision while earning a decent profit. And as profit itself is too narrow measure of success and usually related to shareholders (Friedman 1970), also the perspective of other stakeholders (Freeman 2010) is taken into account while answering the question "Is this company a good one?" or "Is this business sustainable?" Within this perspective and perspective of Spationomy, issues such as the following will be asked and answered:

- Can spatial data and their analysis be a sustainable business itself?
- Can spatial data and their analysis provide the company with relevant information?
- Is it interesting only for specific companies or broad area of business?

Keywords

Business · Finance · Profit · Cash flow · Case studies

6.1 What Is the Goal of a Business?

Frequent answer to that question is that business is focused on earning money or profit. However, it is not valid. While studying the stories of some legendary (and successful) companies, the people who started Harley Davidson, Facebook, Hewlett Packard, Daimler Benz etc., they were not interested in earning money that much, at least at the beginning. They were interested in bringing or developing something new. A lot of companies started as a hobby project, which evolved into something more.

Example 6.1: TILAK

Tilak is a Czech company, producing sporting goods, especially using Gore-Tex®. This company has been set up by

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Example 6.1 (continued)

Mr Roman Kamler. Roman Kamler is Czech rock climber who was missing the "right sleeping bag for rock climber" on the market in the 1980s.In that era, there was no free market in Czech, so it was quite challenging to get high-quality equipment, especially those produced in so-called western countries.

So he took his mother's sewing machine and sewed a sleeping bag for himself based on his design, because who knows better, how a sleeping bag for a hardcore rock climber should look like. He then went on a trek with his friend and the friend's reaction was obvious – what kind of sleeping bag it is, where did he get it etc. remember, Czech rock climbers cannot simply buy high tech equipment. So everyone from the community was curious about each other material and ways how to improve it. At the end of the trek, Roman Kamler was asked to sew one more sleeping bag. He did, and his friend was taking the bag to another trek with other rock climbers. When he returned, he had the orders for eight more sleeping bags. At that moment, Roman Kamler started to think about the possibility of shifting his hobby into the business. Nowadays, the company TILAK belongs to the category of small and medium enterprises (SME). It has more than 60 employees with a turnover of around two mil EUR, exporting their products worldwide (Fig. 6.1).

The pattern of this story has been repeated again and again through history. It started as a hobby, then it got bigger, and now it is business. In the beginning, it is usual to spent own money on the hobby, after a while, when the "hobby" scales up, it has to be financially self-sufficient and even create some financial benefit for the founders – profit.

Fig. 6.1 Roman Kamler is opening a new store of his TILAK company. (Source: www.tilak.cz)

Profit is an essential side effect, crucial and necessary, but it is not the primary one. This opinion is not entirely new, as it goes back to 1999 (Denning Steve 2013a, b; Murray Sarah 2013; Montier 2014).

The real goal of the business is to fulfil a specific mission, create added value and to deliver the value to the customers. In microeconomics, we are talking about "satisfying needs". And of course, this has to be done in the fashion of long term sustainability, including financial sustainability.

The conclusion is simple – business focuses on customers and satisfying their needs while being long-term sustainable (including financially sustainable). Which is not entirely new idea, since it has been declared in 1973 – "The only valid purpose of a firm is to create a customer." – by Peter Drucker (Drucker 2006).

6.1.1 What Is Profit?

If profit is important, what is the profit and how it is measured? From the accounting perspective, profit is the increase in the equity[1] of a firm other than those relating to contributions from equity participants. Simply written, profit is, when the company has higher equity. And the increase of the equity is not because investors have invested more in the company, this increase has to be achieved by earning it. The most common way how to calculate profit is

$$\text{PROFIT} = \text{REVENUES} - \text{COSTS}$$

Total revenues (what has been sold)

– Costs (what we need to spent) such as:
- Labour costs such as wages
- Inventory required for production
- Raw materials
- Transportation costs
- Sales and marketing costs
- Production costs and overhead

For a hot dog stand, revenues are the total amount of sales (sold hot dogs), usually for some period (year, month, etc.). Costs are the value of hot dogs when bought from a supplier, rent of the stand, salary, electricity bills, phone bills etc. again for the same period. Hot dog stand is generating profit only in case the total revenues are higher than total costs. If they are lower, hot dog stand business is suffering the loss.

There are various levels of profit such as:

EBIT – Earnings before interests and taxes
EAT – Earnings after taxes
NOPAT – Net operating profit after taxes
Etc.

For more information about the profit and its various categories, please study more about accounting and financial management such as the classic Principles of Corporate Finance (Brealey et al. 2016). However, any textbook for a basic university course of finance will do.

Example 6.2: Basic Accounting Categories
What are the basic accounting categories and how to understand the profit? This topic is already covered by the theory of accounting, yet it is useful to mention it here.

An **asset (A)** is a resource controlled by the enterprise as a result of past events and from which future economic benefits are expected to flow to the enterprise.
A **liability (L)** is a present obligation of the enterprise arising from past events, the settlement of which is expected to result in an outflow from the enterprise of resources embodying economic benefits.
Equity (E) is the residual interest in the assets of the enterprise after deducting all its liabilities. Hence the equity interlinks the Assets and Liabilities so that we can define the basic accounting equation E = A – L.

The other two basic accounting categories are focused on the changes in equity.

(continued)

[1] To be clear in basic accounting categories please read the IFRS Conceptual Framework or the GAAP Conceptual Framework.

Example 6.2 (continued)

Income is an increase in economic benefits during the accounting period in the form of inflows or enhancements of assets or decreases of liabilities that result in increases in equity, other than those relating to contributions from equity participants.

Expense is decreased in economic benefits during the accounting period in the form of outflows or depletions of assets or incurrences of liabilities that result in decreases in equity, other than those relating to distributions to equity participants.

It is interesting that in the definitions of income and expense, there is not mentioned the cash – even though both categories are usually strongly related to the movement of money. It is not a necessary condition, and both events (income, expense) can occur without the immediate impact on cash. As a result, even the company with high profit (incomes are higher than expenses) can be in financial problems due to the not having enough cash to pay the liabilities and vice versa – a company with loss (expenses are higher than income) can have enough of cash.

Now which company is better, the one with a profit of 1 mil EUR or the one with a profit of 100 mil EUR? If hot dog stand makes a profit of 1 mil EUR per year, it is an excellent performance. If the whole Volkswagen Group makes a profit of 100 mil EUR per year, it is a disaster, as in 2017 Volkswagen Group generated a profit of 11 638 mil EUR (more than hundred times higher than 100 mil EUR), see the appendix 1 – Accounting statements of Volkswagen Group 2017. So merely the profit itself is not a perfect measure for performance measurement if we want to compare various companies or enterprises. That is why the need to compare the profit (the monetary measure of how successful we are) with the sacrifice (the monetary measure of what we have to give up). Therefore, the use of measures such as ROA (Return On Assets), which compares EBIT and total assets:

$$ROA = \frac{EBIT}{A}$$

or ROE (Return On Equity), which compares EAT and shareholders' equity:

$$ROE = \frac{EAT}{E}$$

Another traditional metrics for measuring the performance is ROS (Return On Sales) which shows, how much of the sales (S) is retained in the company as a profit:

$$ROS = \frac{EBIT}{S}$$

All these metrics can be expressed as the indices or in per cent whereas per cent is more common and easy to understand. If we go back to the Volkswagen Group and their annual report for 2017, we see the values as follows[2] (in mil EUR):

A (Total Assets)	422,193
E (Equity)	109,077
S (Sales)	230,682
Operating result (EBIT)	13,818
Earning after tax (EAT)	11,638

Based upon these values the profitability metrics are:

$$ROA = \frac{13\ 818}{422\ 193} = 0,0327$$

$$ROE = \frac{11\ 638}{109\ 077} = 0,1067$$

$$ROS = \frac{13\ 818}{230\ 682} = 0,0599$$

The usual interpretation of these traditional performance measures is:

[2] Even though EBIT is not the same as Operating Result, there is usually no significant difference and Operating Result (or Operating Profit) can be used as a very good approximation to EBIT.

Each 1 EUR of assets generates 3.27 cents to EBIT. Hence the ROA is 3.27%.
Each 1 EUR of equity invested by shareholders generates 10.67 cents of EAT. Hence the ROE is 10.67%.
Each 1 EUR of sales generates 5.99 cents to EBIT. Hence the ROS is 5.99%.

These ratios are not only measuring the performance but since these ratios put into relations the size of the company (measured by the total asset, equity or sales) and the profit, they allow to measure the adequacy of the profit and therefore to compare different companies. These metrics are offering the answer to the question:

"If we invest our money in this company – and therefore become the shareholders of the company – how much do we get back for every 1 EUR invested?"

This perspective – those, who are investing money are expecting the adequate profit – is based upon the shareholder approach, shareholder theory (Friedman 1970). However, the ideas about the profit adequacy are quite old, even though the Pacioli's (Fischer 2000) approach was more focused on profits "too high to be reasonable" and Friedman's approach is more "... increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud."

6.1.2 Profit or Money?

As the accounting perspective – based upon the definitions of accounting categories –income and expense are not necessarily connected with money, and yet if there is the need to invest and gain some return, cash is needed as well as the taking into the account the aspect of time.

Example 6.3: Money and Time
Money can be invested and bring back the return or interest. Let's suppose that there is the opportunity to invest money into the government bonds (investment with almost no risk) and within one year gain the interest of 8% p.a. So if the investment of 100 EUR today is done in bonds, within one year, the value of the investment is 108 EUR. That is why it is better to have 100 EUR today rather than in 1 year, as having the 100 EUR today is not equal to having 100 EUR within one year. 100 EUR today (while having the opportunity to invest in government bonds at 8% p.a.) is equal to 108 EUR in 1 year. In 2 years the investment is $100 * 1.08 * 1.08 = 100 * 1.08^2 = 116.64$ EU. From this perspective, there is (while considering the interest rate of 8% p.a.) no difference between having 100 EUR today or having 116.64 EUR in 2 years.

Principles and relations, which are briefly suggested in Example 6.3, are connected with the time value of money. Time value is focused on future value and present value.

Future value is:

$$FV = PV * (1 + i)^n$$

where

FV is the future value of the present investment,
PV is present value of the investment (what we invest today),
i is the interest rate and,
n is the number of years (duration of the investment).

If the investment is 528 625 EUR at the interest rate of 12% and the investment will be due in 5 years, the future value is calculated as:

$$\begin{aligned} FV &= 528\,625 * (1 + 0,12)^5 \\ &= 931\,617,87\ EUR \end{aligned}$$

Present value is the opposite perspective – it calculates the value of future payments from today's perspective.

$$PV = \frac{FV}{(1+i)^n}$$

What is the present value of the investment, if the investment design is two cash flows worth 1 000 EUR in the second and fourth year, while the interest rate is 8% p.a.? Present value is calculated as

$$PV = \frac{1000}{(1+0,08)^2} + \frac{1000}{(1+0,08)^4} = 1\,592,37\ EUR$$

The present value of the investment is 1 592,37 EUR. Present value can be compared with the required investment. For example, if the investment of 1 800 EUR will generate two cash flows worth 1 000 EUR at the end of the second and fourth year at 8% p.a., it is clear that it is not a good investment, as the present value is only 1 592,37 EUR and it is less than 1 800 EUR. Thus this investment brings negative effect.

Summarising the present values of all cash flows (in and out) while taking the time value of money into account is called Net Present Value (NPV).

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t}$$

where

NPV is Net Present Value,
n is the number of periods,
t is a certain period,
CF_t is Cash Flow in the period t and,
i is the interest rate.

Investment is accepted as long as it generates positive NPV.

What is the NPV of investment into the hot dog stand, if the price of purchase the stand is 10,000 EUR and the stand will generate yearly cash flow of 2000 EUR for 7 years while interest is 4% p.a.?

$$NPV = -\frac{10\,000}{(1+0,04)^0} + \frac{2\,000}{(1+0,04)^1} + \frac{2\,000}{(1+0,04)^2} + \frac{2\,000}{(1+0,04)^3} + \frac{2\,000}{(1+0,04)^4} + \frac{2\,000}{(1+0,04)^5} + \frac{2\,000}{(1+0,04)^6} + \frac{2\,000}{(1+0,04)^7} = 2\,004,11\ EUR$$

A project of the hot dog stand generates positive NPV worth 2004.11 EUR and therefore is acceptable.

From the mathematical perspective, it is clear that the higher the interest (i), the lower the NPV, hence the relation is negative. In economic terms – future cash flows are deteriorated by the interest rate (the more the distant future it is). Figure 6.2 shows the relation between the i and NPV for the hot dog stand investment project.

One of the implications of Fig. 6.2 is – there is interest rate when NPV is zero. This interest rate is called Internal Rate of Return (IRR) and is also used as a criterion for the investment evaluation. For further reading on IRR and NPV see (Brealey et al. 2016).

The profit approach is used mostly in the short term decision making, and the cash flow approach is used for long term decision making. Despite what has been written at the beginning of this chapter – the main goal of business is not making money – profit or positive cash flow is an important requirement for a business to be long term sustainable.

Based upon this interim conclusion two questions arise:

Are Spatial knowledge and related techniques, tools and applications business itself? Can the Geoinformatics, Remote sensing, Urban planning and all the area related to the spatial sciences generate profit and positive cash flow?

And the second question:

Can SPATIONOMY benefit (other) business in general? Is there need and opportunity forthe SPATIONOMY to be part of other (non-geographic area) businesses? Can it help to generate profit and cash flow?

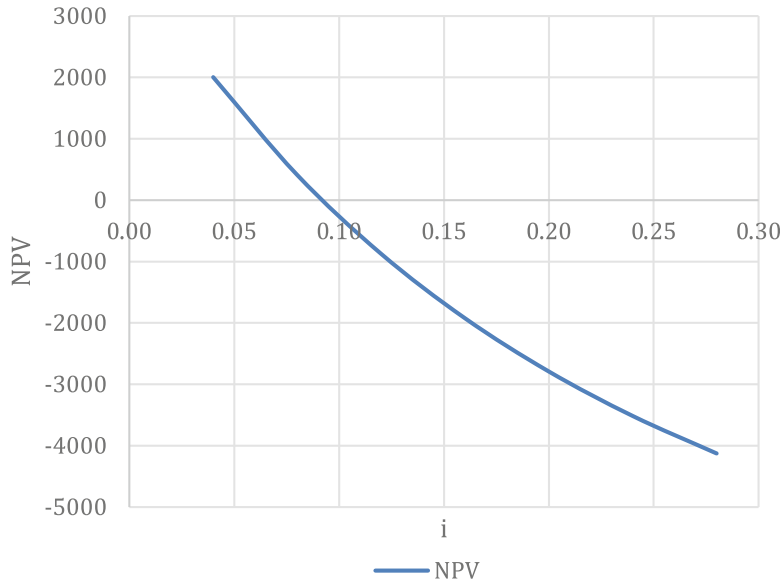

Fig. 6.2 Relation between NPV and I. (Source: authors)

6.2 Spatial Business

Let's start with an example:

Example 6.4: TomTom

TomTom is a Dutch origin company founded in 1991. Today, it is broadly known for its navigation software and applications for car navigation (started in 2001), yet their product and service range is broader (Table 6.1).

What are the numbers for Tom Tom, according to their 2016 annual report?

Based on the numbers it is clear that TomTom is generating profit in both observed years as well as positive cash flow. Relative performance measures, such as ROA and ROE are (Table 6.2)

Is this enough or not? There is no general rule on how high the ROA or ROE should be. Comparison with other companies may reveal at least the position towards them. Volkswagen AG for 2016 achieved ROA 1.73% and ROE 5.79%, Microsoft in 2016 achieved ROA 10.42% and ROE 23.33%. Volkswagen and Microsoft performed better; on the other, both companies are the world top leaders in their fields.

Overall conclusion for this example is – yes, there can be a business built on the spatial information.

Table 6.1 TomTom annual report data

	Thousands of EUR	
Year	2016	2015
Revenues/sales	987,329	1,006,607
Operating result/EBIT	8894	600
Net result/EAT	11,958	18,293
Total assets	1,628,828	1,653,587
Equity	996,737	970,533
Cash flow from operating activities	144,317	118,775

Source: (TomTom 2017)

Table 6.2 TomTom return on assets and return on equity

Year	2016	2015
ROA	0.55%	0.04%
ROE	1.20%	1.88%

Source (TomTom 2017)

Example 6.4 shows that there is a possibility/opportunity for a viable and sustainable business based upon the geo field. There is no final list of all business activities possible; the opportunity to create one will be based upon the innovative thinking, creativity, business vision, scientific and technological development etc. What examples or types of businesses are present on the market so far?

1. Mapmaking – probably the oldest activity, map making was often related to the military and exploring activities. Nowadays commercially produced maps are both printed and digital, sold as an atlas, maps or applications. Examples of such companies are Electronic Chart Centre, Tele Atlas, Ausway or Carta.

   What is the value-added for customer/user? Nowadays (traditional) maps are still used for navigation. Despite the possibility for more advanced digital navigation (see next), traditional paper maps are still in use for navigation because they do not need batteries, they are highly functional in extreme hot or cold conditions, and of course, they are also used as a backup for digital applications. Precise and correct navigation saves time, fuel, improves security (e.g. avoiding collision), decreases the depreciation etc. All these effects will reflect in lower costs hence improving the financial result (profit) and also reducing expenditures, thus increasing the total Cash Flow. This value-added is the primary purpose why customers/end users are willing to pay money for traditional maps.

   Traditional maps (atlases) are also used for educational purposes at any level of the education process. However, this is usually not connected with the business. Still, it is part of the market. There is also a market for traditional maps because of aesthetic reasons – art map can be used as a decoration.
2. Navigation applications – a combination of digital maps, electronic devices and GPS allows developing navigational applications for personal and commercial use. These applications are focused on car navigation, touristic navigation, boat charting and navigational applications and more. Examples of such businesses are TomTom, Navigator, Waze, MX Mariner or BackCountry Navigator.

   The value added is pretty much the same as in the previous case. However, the combination of modern advanced technologies brings many new features to utilise abovementioned benefits. Whether it is the use of mobile digital devices, Artificial Intelligence, Swarm Intelligence etc. all these (especially in combination) can create more value-added to users/customers. The navigation is based upon the current situation (road obstructions, car accidents, road constructions, traffic, etc.) thus overcome the problems of traditional maps – static character and (after a while) obsolete information. Digital navigation can easily update map sources (new roads, new bridges etc.) and in combination with an online connection, the navigation also is improved by the most up to date information.

Example 6.5: Waze

Waze started as the FreeMap Israel in 2006, aiming at – based upon community project and crowdsourcing – creating a free digital map of Israel with up to date information. In 2009 it was renamed to Waze Mobile Ltd. And became commercial. In January 2012 application has been downloaded by 12 million people, on July 20 million. The nature of community project is still present in the application, as it collects data from users to create, update and modify maps as well as to collect actual data related to traffic jams, accidents etc. Well, known is the example of Tour de France, where Waze updated traffic info, especially for this event.

From a business perspective, the year of 2013 is interesting, as Google bought Waze for one billion of USD and employees have been paid on average 1.2 M USD (Teig Amir 2013) which shows how lucrative the business is as Google paid that sum only in faith to earn even more.

3. Location devices or applications – these devices and applications are used when there is the need for fast localisation of person or object, especially when the time is a critical factor. These devices and applications can be suitable in a vast area of situations, from really hazardous situations (such as avalanche beacon) to a simple time- and cost-saving (localising your keys or cell phone). Examples of such devices and applications are PIEPS, Arva, Your Devices at Google Account, Angel Sense, PocketFinder etc.

   Value-added for this application is time saved. The time saved can be just because of the comfort of the users (finding your keys or cell phone) or – in case of life-threatening events – the time is a critical factor. For example in the avalanche, if the victim is dug out in the first 5 min, the survival rate is 90%. After 45 min survival rate is somewhere between 20% and 30%. The probability of surviving the avalanche drops to nearly 0% after 2 h. A similar situation is in the case of a heart attack, where the probability of successful recovery is strongly correlated to the time. If the professional aid is not available within the first 3 or 4 h, almost half of patients do not survive. Therefore users (whether they are rock climbers, skiers, athletes, hospitals, police or law enforcement) are paying for the better probability of survival or saving the time.

As to make an interim conclusion, spatial business is strongly connected with time. To get somewhere faster, to find/localise something or someone faster – and the time is the most significant value-added. Other relevant factors (in business expenses and expenditures) are usually correlated with the time, e.g. the longer the journey takes, the more fuel is consumed, the higher the costs.

In case the business is not entirely based upon the spatial information, there are still potential benefits from using the spatial data, however before exploring them, it is needed to discuss the profit and cash flow more.

Generally accepted axiom for financial management is that higher profit is better than lower profit, ceteris paribus. What means ceteris paribus? It is from Latin, and it means "all other things being equal". What are the other things? In financial management, it usually is risk and liquidity. Sometimes it is called investment triangle (Valach 1997), magic triangle or investing trinity – the risk, return and liquidity. Why triangle? It is often depicted as the following figure.

The triangle depicts three axioms of financial management:

1. It is better to have a higher return (profit, cash flow) than a lower return.
2. It is better to have a lower risk than higher risk.
3. It is better to have higher liquidity than lower liquidity.[3]

Also Fig. 6.3 shows the inherent laws of "2 out of 3" – while investing, it is possible to achieve only two of the three vertices. Thus it is possible to have an investment with:

1. Low risk, high liquidity BUT low return – e.g. government bonds.
2. High liquidity, high return BUT high risk – e.g. shares of new tech companies, such as Waze in the past.
3. High return, low risk BUT low liquidity – e.g. investment in the real property, such as buying a flat and renting it.

Since the axioms mentioned above are taken as valid, the financial management usually aims to increase return, increase liquidity and decrease

[3] Liquidity is the feature how quickly can be something purchased or sold on the market. Money are the asset with the best liquidity, land is the asset with very low liquidity.

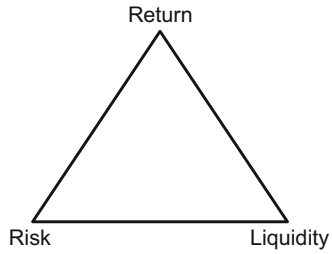

Fig. 6.3 Investment triangle. (Source: authors)

or reduce risk. How to increase the return? As has been demonstrated at the beginning of this chapter, profit is connected with revenues and expenses. Revenues are generated through sales – the more we sell, the higher the revenues. Costs may or may not be influenced by the volume and profit is the difference between total revenues and total costs.

Example 6.6
It is possible to apply a more analytical approach to the Hot dog stand example from the beginning of the chapter. This information related to the hot dog stand is available:

For a hot dog stand, revenues are the total amount of sales (sold hot dogs), usually for some period (year, month, etc.). Costs are the value of hot dogs when bought from a supplier, rent of the stand, salary, electricity bills, phone bills etc. again for the same period. Hot dog stand is generating profit only in case the total revenues are higher than total costs. If they are lower, hot dog stand business is generating the loss.

Revenues are a function of the volume, total revenues (sales) are the equal price for unit multiplied by the number of units (hot dogs) sold. Costs are slightly more complicated. Some costs, such as hot dogs bought from suppliers are a function of volume – the more hot dogs are sold, the more costs of buying hot dogs are expensed. These type costs are labelled as **variable** costs. On the other hand, rent is not influenced by the volume of hot dogs sold; these type of costs are labelled as **fixed** costs.

As this kind of decision making is based upon the **c**osts, **v**olume and **p**rofit, it is often called CVP analysis. CVP analysis can be based upon the non-linear model. However, this model is more difficult to use, and the benefits of better accuracy do not overweight the problems. That is why the linear CVP model is used. Linear CVP model is based on the relation:

$$\text{Profit} = \text{Revenues} - \text{Costs or } P = R - C$$

This model is called linear because it assumes all the relations within are linear. Hence the model can be transformed into:

$$P = P_u * Q - VC_u * Q - FC$$

where,

P_u is the price per unit,
Q is the volume of units sold,
VC_u is the variable costs per unit,
and FC are fixed costs.

As rational business is selling for more than variable unit cost ($P_u \geq VC_u$), the positive difference per unit is called margin per unit or contribution per unit. The total sum of these unit contributions generates total margin or contribution margin. This is how the business generates profit. In the beginning, the total margin is lower than fixed costs and business creates a loss; after covering the fixed costs, the business generates profit.

Example 6.7
In the extension of the previous example with a hot dog stand, the following assumptions will be introduced:

(continued)

Example 6.7 (continued)

P_u for one hot dog is 3 EUR, VC_u for one hot dog is 2 EUR, FC is 1200 EUR per month. What is the profit for various volumes of sold hot dogs?

Conclusions made based upon the Table 6.3 are apparent – until a specific volume the business is losing money, it is not worth to start the business unless the demand for the product or service is big enough. After a certain volume, business is making money. At a precise moment, business is not losing nor making money – it is called the breakeven point.

Table 6.3 Linear CVP model of hot dog stand

Q	R	VC	FC	P
0	0	0	1200	−1200
300	900	600	1200	−900
600	1800	1200	1200	−600
900	2700	1800	1200	−300
1200	3600	2400	1200	0
1500	4500	3000	1200	300
1800	5400	3600	1200	600
2100	6300	4200	1200	900

Source: Authors

The breakeven point is a moment when previous conclusions (losing money) are changing, yet new conclusions (earning money) are still not valid. From the perspective of the CVP analysis, breakeven point (often abbreviated to BEP) is the volume of units sold, where total revenues are equal to total costs. Hence profit is zero. In Example 6.7, the breakeven point is 1200 units (hot dogs).

How to calculate the breakeven precisely? BEP is defined as the volume (Q) when total revenues are equal to total costs:

$$TR = TC$$

which is the same as

$$P_u * Q_{BEP} = VC_u * Q_{BEP} - FC$$

So basically it is equation with one variable (Q_{BEP}). The solution of the equation is, therefore (based on the standard mathematical operation):

$$Q_{BEP} = \frac{FC}{P_u - VC_u}$$

The volume for the breakeven point (Q_{BEP}) is essential information for business, as it is the answer to the question "How many customers we need to have not to lose money?" On the other hand, the business usually expects some profit for further development, research, corporate social responsible action etc. Hence the question is modified "How many customers we need to have to earn a certain profit?". In Example 6.7, hot dog stand business needs to have 1800 sold hot dogs per month, to earn a profit of 600 EUR. Precise calculation of the volume for specific profit is:

$$Q_{PROFIT} = \frac{FC + P}{P_u - VC_u}$$

CVP analysis is not strictly limited only on business decision making; it can be as well applied in other areas.

Example 6.8

Health insurance system pays to the hospital 1500 EUR for the non-complicated upper limb fracture treatment.

The treatment requires variable costs (plaster or fibreglass cast, etc.) of 60 EUR. Fixed costs of the Trauma department (the simplifying assumption is that it is strictly devoted to non-complicated fractures, providing no other treatment) are 2,500,000 EUR per year. The statistical probability of upper limb fracture is p = 0.0439. Now, how populated has the hospital gravity field to be, so the total average costs per treatment are within the limit of the 1500 EUR?

Formally, the total average costs (AC) – total costs divided by the quantity - have to be less or equal to 1500 EUR, therefore inequality:

(continued)

Example 6.8 (continued)

$$AC = \left(VC_u + \frac{FC}{Q * p}\right) \leq 1500$$

As the only unknown variable is Q, the inequality can be transformed (logical assumptions are VC_u, Q and p are positive values) into inequality:

$$\frac{FC}{(1500 - VC_u) * p} \leq Q$$

After filling in the numbers, the inequality gets this form:

$$\frac{2500000}{(1500 - 60) * 0,0439} \leq Q$$

Hence the result is:

$$Q \geq 39546,95$$

The gravity field has to have at least 39,547 people, so the average costs per treatment are within the limit of the health insurance system. Even though the assignment is very simplified (based upon simplifying assumptions), the underlying philosophy is correct – certain public services, such as hospitals, city public transport etc. are connected with a critical mass of the population – there have to be enough people demanding the service to provide the service.

CVP analysis also shows why there are the urge and effort for growing – the bigger the volume, the higher the margin and profit. On the other hand, it also shows the other way how to improve profit – to reduce unit costs or fixed costs. Both these ways – increasing the volume and reducing the costs – can be supported and applied. CVP analysis can be also used for another type of decision making.

Example 6.9

The present situation with the hot dog stand is 1800 sold hot dogs per month for the unit price of 3 EUR, while hot dogs are purchased from suppliers for 2 EUR. Fixed costs are 1200 EUR per month.

The hot dog business is considering the opportunity to improve marketing by creating posters and running the banners on social networks. Expected costs of these activities are 300 EUR. Expected result of these activities is increasing sales by 25%.

Is the money in the marketing well spent?

Incremental costs (or marginal costs) of decision are 300 EUR increase in fixed costs and also the extra costs spent on extra hot dogs sold. The increase is 25% which corresponds to 450 extra hot dogs. Hence incremental variable costs are 900 EUR (450 ∗ 2). The total increase in costs is 900 + 300 = 1200 EUR, that is how the costs will change in case the decision is made. An alternative decision is to do nothing, and costs remain unchanged.

Revenues will be changed (increased) due to the decision by 1350 EUR (450 ∗ 3). As the increase in the revenues is higher than the increase in the costs, the decision – spent money on marketing – will benefit the business.

As each sold hot dog causes extra 3 EUR in revenues and additional 2 EUR in variable costs, the benefit of each sold hot dog is 1 EUR in the margin. The decision can be made based upon the unit margin and the incremental margin. As marketing should bring an extra 450 units, it should also bring additional 450 EUR in the margin. As the increase in margin is 450 EUR, it is higher than the increase in fixed costs of 300 EUR due to the marketing expenses. This is enough information to decide that the extra 300 EUR is money well spent, the impact on the profit (and cash flow as well) will be extra 150 EUR.

In Example 6.9, the decision problem is defined as the trade-off between increased fixed costs and increased volume, where volume will

result in increasing the margin. This type of decision making can be described as "What – if". In this case, the question is "What will happen if the company spend more on marketing? Is it a good decision?" Of course, it is challenging to estimate the impact of the marketing expenses, and it is almost sure that the effect will not be precisely 25%. However it is possible to reverse the logic of the example and redefine the decision making into the question: "In case we spent 300 EUR on marketing, how big the impact on the volume has to be so we do not lose the money?" As already explained in Example 6.9, each hot dog sold brings extra 1 EUR of margin. Hence the minimum impact of the marketing must be extra 300 hot dogs sold. Each hot dog above the 300 units is generating profit.

Example 6.10

The hot dog stand is growing and being successful; there is the offer to join – based on the franchise – a worldwide network of the fast-food chain. The franchise has to be paid every month 400 EUR. However, the franchise chain will supply its hotdogs for the 15% discount. The current volume is 1800 sold units (hot dogs). However, there is the expectation of increasing our customers by 5% based upon the fact of becoming a brand.

Is it – from a financial perspective – right decision?

The present situation is based upon the equation:

$$P = P_u * Q - VC_u * Q - FC$$

Hence the profit is:

$$P = 3 * 1800 - 2 * 1800 - 1200 = 600 \text{ EUR}$$

The alternative situation is based upon a modified equation:

$$P = P_u * Q * (1 + 0,05) - VC_u * (1 - 0,15) * Q * (1 + 0,05) - (FC + 400)$$

The profit of the alternative option is:

$$P = 3 * 1800 * 1,05 - 2 * (1 - 0,15) * 1800 * 1,05 - (1200 + 400) = 857 \text{ EUR}$$

As the profit for the alternative option is higher than the present situation, from a financial perspective, it is a good decision to join the franchise.

All these examples (Examples from 6.6 to 6.10) show how even the simple linear CVP model can be used for various decision making, analysing different situations and comparing them. Also based upon the linear CVP analysis – from the perspective of the mathematic equation – profit (or cash flow) can be improved by increasing revenues or decreasing expenses. This conclusion is not surprising. However, it suggests how the Geo part can play a useful and significant role for companies – either it will increase revenues or decrease expenses.

6.3 Business and Spatial issues

How the spatial methods can be used in a business is shown based upon the two case studies. A first case study is based upon the Cyclone Kyrill; second case study is based upon the application Urban Planner.

6.3.1 Case 1 – Cyclone Kyrill

Cyclone Kyrill (or Storm Kyrill) was extratropical cyclone with hurricane-strength winds which formed on the 15th January 2007

and dissipated the 24th January 2007. This winter storm was very destructive and caused significant damages and disruptions across ten countries in Europe. Kyrill claimed 47 lives (13 of them in Germany) and economic losses are estimated to USD 12 billion (Tatge, 2017).

Kirill hit Ireland and Great Britain in the evening the 17th of January 2007, crossed the North Sea and in the afternoon of the 18th of January hit Germany and Dutch coasts. Kirill than moved to Poland and Russia moving over the Baltic Sea.

During the storm, the wind speed was high above the 100 km/h with a record of 202 km/h on the Wendelstein in Germany.

More than two millions of households were without electricity across the affected parts in Europe, trains completely stopped, hundreds of flights have been cancelled, people were sleeping in stranded trains etc.

Among other damages and problems, Kirill caused devastation on forests in the affected area. According to the Beaufort scale – scale for measuring the wind speed – the storm of the strength 10 is strong enough to uproot trees. Kirill was up to the 12, which classifies it like a hurricane. Thus the damage is described as devastation.

From the perspective of the company which operates in forestry, this type of event will cause damage to the assets. Based upon the strength/wind speed, the damage could range from broken/fallen twigs and branches to broken trees up to complete devastation. The issue is to evaluate the loss in economic terms – how significant the damage is in the monetary unit. The need is to get precise information about the damage. The more we spent our resources (time, money, labour) on the information, the better (precise, relevant, etc.) the information is. The traditional approach has been based upon the personal reconnaissance; someone must walk through the area or observe it from higher ground and estimate the damage. The problems were of several kinds. First, the damaged forest is unstable, some trees clinched, locked, weakened etc. and therefore even light breeze can cause another collapse, hence endanger the safety of workers, who were providing the estimations.

The second problem is the timeliness – precise information is valued if it is provided on time. The more accurate information is required, the more time it takes to get it. So there is the trade-off between the precision and timeliness and costs. It is not a wise decision to spend 5000 EUR to get the information "Damage is worth 500 EUR" nor is it wise to get precise information after a couple of months or years.

Modern approaches offer more sophisticated tools to solve the problem. The tool or the field which can be applied is called remote sensing. For more information on remote sensing, see subchapter 1.5. The company, instead of sending workers in a dangerous area, can get aerial images or satellite images of the area and based upon the images, the estimation can be done.

The first picture (Fig. 6.4) is taken before the Kirill occurred, and it is a random picture from Germany.

The areas with forest can be easily identified by the plain eye, more precise yet very simple estimation can be done by putting a rectangular grid pattern on the image and estimate the % of the forested area. The grid is shown in Fig. 6.5.

The smaller the dimension of a rectangle, the more precise the measurement, however also the more challenging to calculate. Of course, if more advanced tools are applied, such as image analysis, than the tedious work can be done by the computers (especially if the image is a digital one).

The image of the post – Kirill situation is shown in Fig. 6.6.

The deforestation because of the Kirill Storm is visible. Whether the image is gathered via drone or downloaded from free or paid source, the benefits of this attitude are apparent – it is fast, cheaper, precise and much safer for the workers. Thus the remote sensing and image analysis saves costs and thus improving the profit and cash flow.

The damage estimation itself is quite simple: Value of 1 hectare of the forest (may depend on the age of the forest. However this information is available for the company) x number of hectares damaged or destroyed. Thus the company, thanks to the remote sensing, has better information in less time and for less money (lower costs).

Fig. 6.4 Image of the landscape before the Kirill Storm. (Source: Land NRW (2018/2009/2006)) Datenlizenz Deutschland-Namensnennung-Version 2.0 (source www.govdata.de/dl-de/by-2-0)

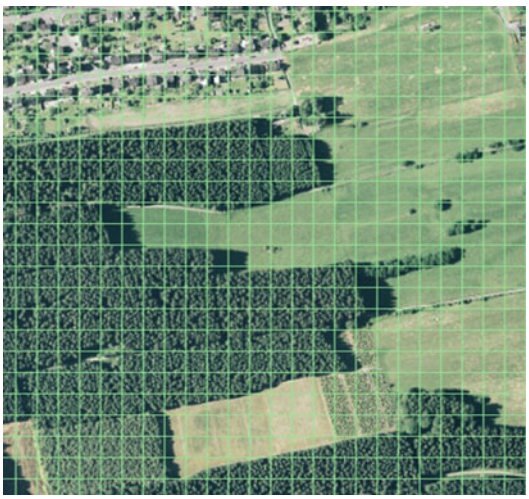

Fig. 6.5 The rectangular grid on the landscape image. (Source: Land NRW (2018/2009/2006)) Datenlizenz Deutschland-Namensnennung-Version 2.0 (source www.govdata.de/dl-de/by-2-0)

The company can approach this problem also form different attitude and demand this information from a specialised company as a service. This is called **outsourcing,** and the basic idea (applied on the forestry business) is: "We are experts in forestry, we are not experts in other fields, we will find experts on remote sensing and image analysis and hire them to do the job." The outsourcing approach suggests that viable business based upon the remote sensing may be possible and of course, it is.

6.3.2 Case 2 – Urban Planner

When companies are considering the location of its headquarter, production site, shop etc. they are considering different variables, as this decision is rarely one-dimensional. The issue of choosing the best location is therefore based upon the multidimensional decision making.

Fig. 6.6 Image of the landscape after the Kirill Storm. (Source: Land NRW (2018/2009/2006)) Datenlizenz Deutschland-Namensnennung-Version 2.0 (source www.govdata.de/dl-de/by-2-0)

Example 6.11: Multidimensional Decision in Sport

Every year there is a sporting event when shooters are competing in three different disciplines. The first discipline is rimfire pistol, distance is 25 meters, and the target is standard 50/20 according to the ISSF where the best score is 10 point, the circle with 10 is 50 mm wide. Competition is ten rounds theoretical maximum is 100 points. The second discipline is rimfire rifle, and the distance is 50 meters, the target is the ISSF air rifle target with the ten as maximum, and the ten circles is 11,5 mm. Competition is again ten rounds, and the theoretical maximum is 100 points. Finally, the third discipline is centerfire pistol steel targets, and the main aim is to knock down five steel targets as fast as possible, best shooters finish this discipline between 5 and 6 s.

Any shooter can be immediately disqualified for safety violations – as for this sport, this is extremely important – and for unsportsmanlike conduct.

To determine who is the best shooter in a separate discipline is quite easy. In first two, it is the shooter with the highest points, in the last discipline, it is the shooter with the shortest time. Table 6.4 presents the model results for 20 shooters in each discipline and to find the best one in each is quickly done by the naked eye.

However, to determine, who is the best shooter of the day, that is a multidimensional problem. Also other issues are how to measure and how to compare various metrics and measures as some metrics are positive (it is better to have high values such as points), some are negative (it is better to have lower values, such as time), some have limited values (it is impossible to get 160 points based upon 10 shots), some have unlimited values (theoretically there is no time limit for steel targets), etc.

(continued)

Example 6.11 (continued)

Table 6.4 Results of the competition

	Name	Rimfire pistol Points	Rimfire rifle Points	Steel targets Time
1	Alice	82	74	7.7
2	Brenda	60	65	11.54
3	Cecil	67	78	6.73
4	Donna	80	80	12.07
5	Eve	41	42	14.03
6	Frank	93	78	7.86
7	Gina	93	92	8.81
8	Hana	86	87	9.05
9	Ivan	86	80	11.2
10	John	49	54	9.05
11	Karl	47	83	7.53
12	Lena	64	64	11.34
13	Mike	86	91	6.2
14	Nora	75	64	6.81
15	Oscar	56	76	8.45
16	Peter	85	89	4.63
17	Quinn	61	61	8.5
18	Robert	76	86	11.28
19	Stefania	88	92	9.95
20	Tim	89	94	6.62

Source: Authors

The first possible approach towards the problem is ranking. The ranking is based upon ranks to determine who is first, second, third etc. in each discipline separately. This is usually easy and is based upon simple measurement and determining ranks. After that, the sum of ranks for each competitor is calculated. Theoretically, if there is a competitor, who is best in all three disciplines, the best (minimum) value is 3. The best competitor is the one with the lowest rank-sum. Ranks are shown in Table 6.5.

Based on Table 6.5, it is possible to determine the best shooter of the whole contest, and it is Tim, who has the lowest sum of ranks. There are two third places (Gina and Peter), etc.

In case there are exactly 20 competitors, the relative difference between each rank is exactly 5%, which is not necessarily the truth. The difference between Tim (rank 3 in the first discipline) and Stefania (rank 4 in the first discipline) is one point. Because the maximum is 100 points, the difference is 1%. The two competitors have practically the same result. However, the ranking approach conclusion is that the gap between 3rd and 4th place is 5%. Theoretically, if there are two competitors (A and B), two disciplines (I and II) and results are as shown in Table 6.6, there is the wrong conclusion.

The ranking approach suggests both competitors equal, which is not valid, as they are (almost) equal in the discipline II.

(continued)

Example 6.11 (continued)

Table 6.5 Ranking

	Name	Rimfire pistol Rank	Rimfire rifle Rank	Steel targets Rank	Rank Sum	Final rank
1	Alice	9	14	7	30	10
2	Brenda	16	15	18	49	18
3	Cecil	13	11	4	28	8
4	Donna	10	9	19	38	14
5	Eve	20	20	20	60	20
6	Frank	1	11	8	20	5
7	Gina	1	2	11	14	3
8	Hana	5	6	12	23	7
9	Ivan	5	9	15	29	9
10	John	18	19	12	49	18
11	Karl	19	8	6	33	11
12	Lena	14	16	17	47	17
13	Mike	5	4	2	11	2
14	Nora	12	16	5	33	11
15	Oscar	17	13	9	39	15
16	Peter	8	5	1	14	3
17	Quinn	15	18	10	43	16
18	Robert	11	7	16	34	13
19	Stefania	4	2	14	20	5
20	Tim	3	1	3	7	1

Source: Authors

Table 6.6 Ranking issue demonstration

	Disciplines					
Competitor	I	II	Rank I	Rank II	Rank Sum	Final rank
A	100	99	1	2	3	1
B	35	100	2	1	3	1

Source: Authors

However, different in discipline I. However ranking system is assuming an equal difference between ranks, thus smoothing the differences. One possible solution for this issue is the relative approach to ranking.

The relative approach is based upon comparing the competitors to the best result. The best result can be the theoretical best (100 points for the first discipline in this example) or the real best (the best result achieved by a competitor). The best result represents 100%, and the other results are also calculated in % to show the relative difference between competitors. The relative rank is calculated based upon simple mathematical formulas, different for positive and negative metrics.

(continued)

Example 6.11 (continued)

Table 6.7 Relative ranks

	Name	Rimfire pistol (%)	Rimfire rifle (%)	Steel targets (%)	Sum	Final rank
1	Alice	88.17%	78.72%	60.13%	227.03%	8
2	Brenda	64.52%	69.15%	40.12%	173.79%	18
3	Cecil	72.04%	82.98%	68.80%	223.82%	9
4	Donna	86.02%	85.11%	38.36%	209.49%	13
5	Eve	44.09%	44.68%	33.00%	121.77%	20
6	Frank	100.00%	82.98%	58.91%	241.88%	5
7	Gina	100.00%	97.87%	52.55%	250.43%	4
8	Hana	92.47%	92.55%	51.16%	236.19%	7
9	Ivan	92.47%	85.11%	41.34%	218.92%	10
10	John	52.69%	57.45%	51.16%	161.30%	19
11	Karl	50.54%	88.30%	61.49%	200.32%	14
12	Lena	68.82%	68.09%	40.83%	177.73%	17
13	Mike	92.47%	96.81%	74.68%	263.96%	3
14	Nora	80.65%	68.09%	67.99%	216.72%	11
15	Oscar	60.22%	80.85%	54.79%	195.86%	15
16	Peter	91.40%	94.68%	100.00%	286.08%	1
17	Quinn	65.59%	64.89%	54.47%	184.96%	16
18	Robert	81.72%	91.49%	41.05%	214.26%	12
19	Stefania	94.62%	97.87%	46.53%	239.03%	6
20	Tim	95.70%	100.00%	69.94%	265.64%	2

Source: Authors

– Positive metric

$$\frac{evaluated\ entity\ value}{best\ (highest)\ value} * 100\%$$

– Negative metric

$$\frac{best\ (smallest) value}{evaluated\ entity\ value} * 100\%$$

Relative rankings calculated for the model data are presented in Table 6.7.

In this approach, there are no issues having two competitors with the same score, and in this approach, the differences are calculated more precisely. That is why there is very little difference between Tim and Stefania in the first discipline. This approach also changed the winner, this time it is Peter with an overall score of 286.08%. Former winner Tim is second, third place is Mike.

There are several other options, how to calculate the final score or rank from various variables and choose the best option. The important lesson learned based upon this simple example is

- Measurement is not neutral, as various measures can cause varying results.
- Methods of measurement should reflect our needs, preferences, values, etc.
- To represent sets of parameters or variables by one measure (number) is tricky.

What can be the variables, considered by companies (or institutions) while choosing the location?

(a) Transport infrastructure – based upon the nature and field of business, requirements to be within a certain distance from the highway, international airport, train station etc. can be made. Being closer to the transport infrastructure will reduce costs of transport thus improving cash flow and profit, on the other hand, transport is usually caused of air pollution, and for some businesses, this can be harmful (health care, wellness, ecological agriculture etc.). That is why this variable can be positive or negative, depending on the needs.

The economic impact of this variable is usually projected in expenses. The bigger the distance between the producer/provider and customer/consumer, the higher the transportation costs. Producers generally prefer a location closer to the transport infrastructure; residential areas usually prefer a more distant location.

(b) Power supply – certain companies have specific requirements for power supply. In Prague (Czechia) the company Prusa Research, who is the producer of 3D printers, needed the high power supply for the biggest print farm in the world and this requirement (among others) was the primary motivation to change location in 2017.

The economic impact of this variable is almost binary (and thus similar to the Example 6.10 safety violation rule), the location either offer sufficient power supply or not. In case there is not enough power supply, the site is either unsuitable, or it requires investment (expenditures and costs) to improving it.

(c) Employees – companies require employees with a specified set of skills and opening the branch in a specific location can be motivated by this factor. It is not a coincidence that important innovative hubs (such as Silicon Valley) are close to excellent research and educational institutions (in the case of Silicon Valley it is Stanford University).

The economic impact of this variable is also focused on expenses. If the employees (with a needed set of skills, education, experience etc.) are scarce in a certain location, they require higher salaries (for example to leave their current jobs and move to the new one), employee benefits etc. and all these will reflect in higher costs. On the other hand, if the unemployment rate is higher (there is a lot of skilled worker in the labour market, willing to work) than of course salaries can be lower.

(d) Customers – business, which delivers products and services to the consumers or end-users and business which is required to supply in Just In Time manufacturing also need to consider the distance from customers. At the beginning of this chapter, the hot dog stand is a typical example of a business, which needs to be close to the customers.

The economic impact of this variable can be on revenues; this is valid for the businesses focused on personal services or selling goods to the consumers (restaurant, hot dog stand, supermarket, etc.). The area with more customers is positively correlated with higher revenues.

In the case of Just In Time manufacturing the distance between the producer (supplier) and the customer will affect transportation costs.

(e) Ecological and safety restrictions – certain business cannot be located nearby water sources, protected areas, populated areas etc. One example is EXPLOSIA, a.s., which is a company producing explosives. Historically it was located outside the city of Pardubice (Czechia) in 1920, however as the city of Pardubice grows (today the population of Pardubice is around 90 000 inhabitants), the current situation is that the risky business is operating in the suburb of a highly-populated area. On the other hand, in Pardubice, there is also a university, which initially started as Chemical Institute in

1950, thus confirming the paragraph ad c) Employees.

The economic impact of these regulations and restriction can be total – certain plants cannot be located in certain areas. In other cases the effect is relative – companies must spend extra money (thus increasing costs) on environment protection, such as sewage plant, noise barrier etc.

This is not the complete list of all considered variables. However, it shows that the variables are miscellaneous, sometimes contradictory, sometimes positively correlated, sometimes negatively correlated. The final decision is always the result of considering all relevant and important variables, evaluating them and choosing the best option, whether based upon ranking, relative ranking or other multi-criteria decision methods.

Each variable will, in the end, somehow project into the cash flow and profit; the company will either be harmed or benefited.

A lot of the variables mentioned above are connected with the location of a certain phenomenon. That is why the tool, which helps companies answer the question "Where to locate new plant/shop/ service centre . . .?" can save a lot of money for companies or earn a lot of money for the companies. Such tools exist, and they are based upon combining different map layers. Layers cover the information for the location-based decision making and the first step in the analysis is usually the selection of variables. One of the possible set of variables (or factors) is displayed in Fig. 6.7.

In this approach, it is possible to fine-tune the importance of each variable to adjust it to the needs of the decision-makers. Each factor can also be set more precisely by adjusting the weights to the actual needs of the decision-makers as seen in Fig. 6.8.

After the setting and adjusting the variables (factors), the analysis is done by the software automatically. Output can be presented to the users in numerical/digital format (as a set of tables with determined values) or in graphical form, as shown in Fig. 6.9.

White areas are unacceptable; they do not meet the required parameters. Blue areas are the areas which fit the required parameters, the darker the

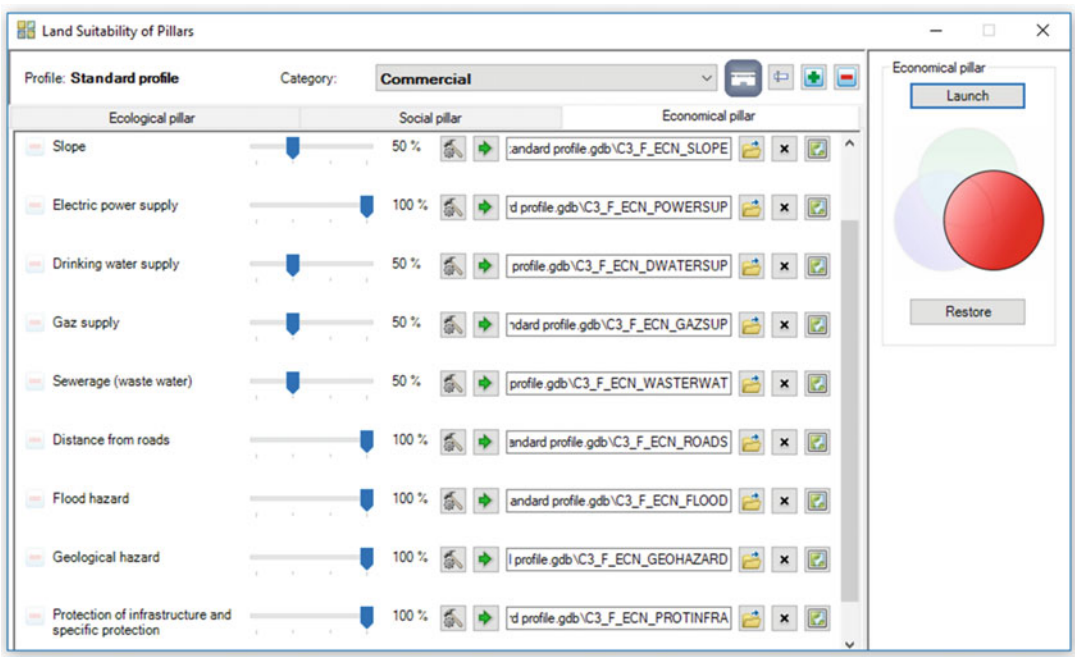

Fig. 6.7 Factors and variables are setting. (Source: authors)

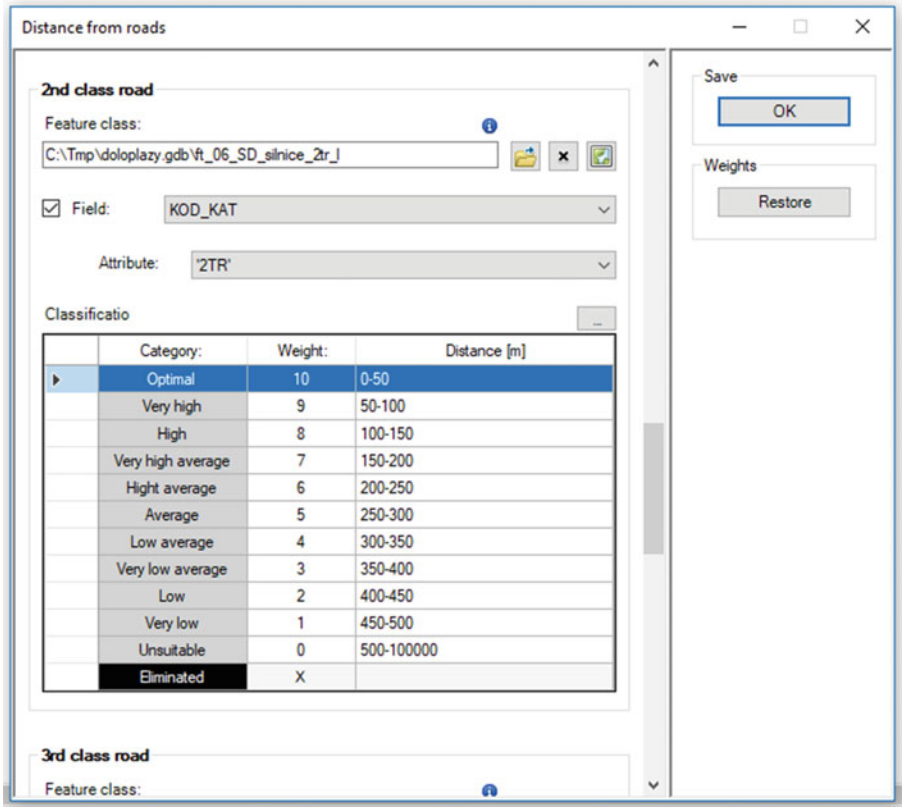

Fig. 6.8 Adjusting the weights. (Source: authors)

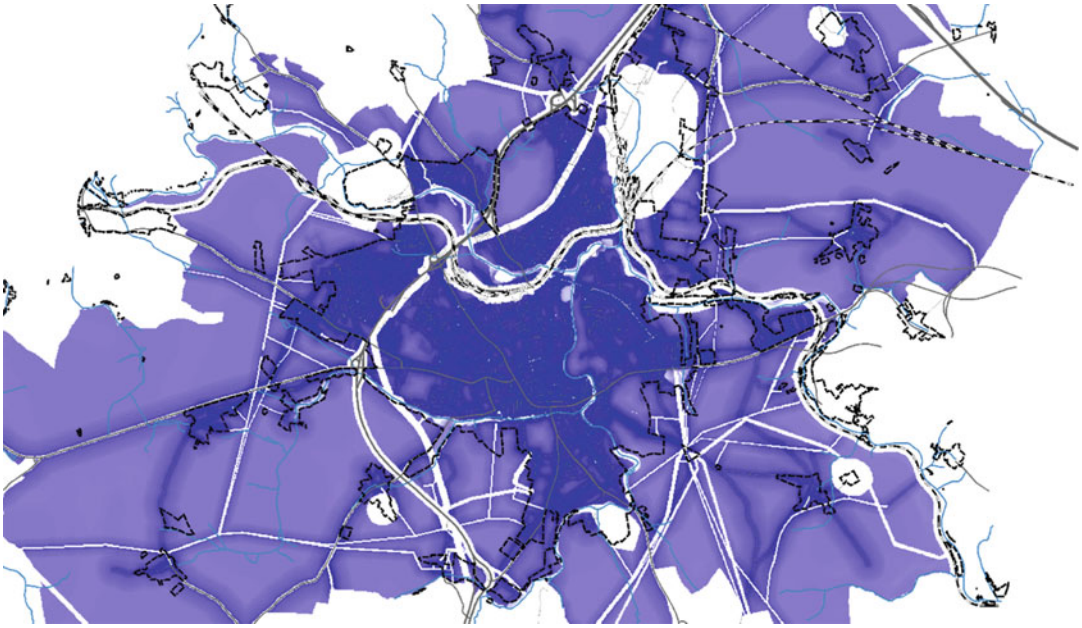

Fig. 6.9 Output presented in the visual image. (Source: authors)

blue, the better the fit. Based upon the outputs, the decision regarding the localisation can be made, in this case, the dark blue areas (lines) are the best options.

6.4 Summary

In this chapter, it has been shown how the business is connected with generating added value for customers. Generating profit and cash flow, even though it is not the true goal of business, is an important and crucial condition of the long term sustainability. Various measures of the profit and cash flow have been used and demonstrated.

In the second part of the chapter, the connection between business and spatial methods has been demonstrated. The first attitude was based upon creating or running the business on spatial expertise. The second attitude has shown how companies from other areas can benefit from the usage and involving of spatial methods.

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