The PILOT Method

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While advanced decision-making support is often performed by a software tool, we will in this paper take a look at how easily decisions can also be made using only pen and paper by following the PILOT Method. PILOT is not an acronym but refers to being in the pilot's seat when making real-life decisions if the method is followed. The method is the result of many years of research and validation. It is based on observations on what information people can easily provide and handle with reasonably preserved quality. As such, the method does not rely on unrealistic assumptions about decision-makers' time and resources to achieve impeccable decisions. The PILOT Method allows the decision-maker(s) to sit in the driver's seat when they are going to make decisions that require reflection, either alone or as part of a group. In other words, become their own decision pilot(s) with the ability to control decision situations without too much risk of making mistakes.

The PILOT Method consists of five decision stages that we will now look into. We will provide a worked-through example to illustrate the stages. The example comes from a personal decision but this does not mean that the PILOT approach is any less suited to decisions for businesses or organisations than to personal decisions. Not at all. The example was chosen so that most readers can recognise themselves and be able to relate to the different decision stages easily. Note that the terms *alternative* and *option* will be used interchangeably in this description to lighten up the text – they refer to the same thing.

The method comes in two versions comprising four and five stages, respectively. The four-stage method (PM4) considers the cost aspect from the very start of the process, while the five-stage method (PM5) focuses on functionality in the first four stages and devotes the fifth stage entirely to the cost aspect. The versions are identical if there is no cost aspect involved in the decision. The first three or four stages of the method ensure that we gradually work towards better and better decision information in terms of the features and functions of our options for action. The last stage is the final evaluation of our information base. At each stage, our information base gains in quality. But already after the first stage, we will have a fully operational decision-making basis, and for some decisions, we might decide to make do with that. Time is money, and there are many decision situations where the most preferable option becomes clear relatively early in this process. In that case, there is no need to continue with more stages or analyses. The PILOT Method is divided into the following stages:

1. First, we create a pro-and-contra (P-C) list for each alternative. Such a list includes the advantages and disadvantages we can see. We might already make our decision at this point.

2. Otherwise, we record the important characteristics of the possible options in the decision. This may be enough to make our decision.

3. Otherwise, we rank all the options under each criterion separately. This will give us an excellent basis for our decision.

4. If we continue, we assign weights to the criteria according to a ranking order. In PM4, we are now ready for our final decision, while in PM5, we are almost there.

5. In PM5 only, the fifth stage manages the trade-off between cost versus functionality and features of our available options.

Why two versions of the method? There are two distinct types of decision situations. On the one hand, there are decisions where we choose between alternative courses of action either primarily based on their functional properties or where cost is a perspective among others, albeit often the highest-ranked criterion. For these decisions, using PM4, the outcome (decision) is settled at the latest after the fourth stage or earlier after as many stages as we see the need to complete. On the other hand, some decisions primarily focus on the most cost-effective option, often not the option with the best functional properties, but instead combines reasonably good properties with a low cost. Using PM5, the fifth stage is separate and necessary for this type of decision in order to find the most cost-effective option, no matter how many of the previous four stages we carry out to rank the options functionally. As examples of the latter type of decision, procurements come to mind.

A decision analysis using the PILOT Method has two equally important effects. The first is reaching clear and, as far as possible, accurate results from the completed procedure. The results give a good indication of which decision to make. However, we should always bear in mind that decision analysis is the basis for the decision and that a human decision-maker always makes the real decision. The second effect, which is just as important, is the increased awareness and understanding of the options and the entire context for the decision, which is achieved by illuminating the decision problem. Options are what we consider when choosing between what we are going to do. The second parameter is what we consider important, that is, our criteria for choosing. These must be clear and understandable. The effects of these insights are important, not least when a group should make a decision or when investigators prepare a basis for a decision that needs to be communicated to policymakers or to a management team.

STAGE 1 – P-C LISTS

So, how should we approach a decision problem? The first stage is to find out which options are available. Sometimes, it is relatively easy to list these, but sometimes, they are harder to identify. In many cases, creating a process similar to brainstorming is favoured in which creative options of action are produced without the restriction that they must be guaranteed to be realistically feasible. In other cases, there are numerous possible options, but having more than ten in an analysis is rarely advisable. With many more options, it is best to divide the analysis into two phases. In the first phase, representative and particularly attractive options are included for each type or cluster of options. When the first phase is completed, the analysis will indicate one or two most attractive types. Then, in the second phase, more options from these preferred types can be included in a more refined analysis. If such a division cannot be made, then there is no formal reason not to include a large number of options in an analysis with only one phase, but in practice, it might become cumbersome.

Example: Lilly and Larry live with their son, Fido, and their dog, Smilla, in a small apartment in the town centre. Fido is soon to start school and needs his own room. For some time, the family has been considering moving from the city centre to a larger apartment in a suburb. However, there are many suburbs, and the choice is not easy. Lilly and Larry have looked at about fifty apartments in the past year but have not been able to decide, and now the start of the school year is approaching rapidly. Above all, buying a larger apartment seems both expensive

and a bit scary, but also difficult because there is such a huge selection available and the market is so capricious and nothing quite feels like value for money. They decide to use the PILOT Method to determine which apartment to buy.

They begin with Stage 1 by writing down the apartments they have looked at and liked for whatever reason. It turns into a rather long and confounding list, but when they group them by residential- or rather, the type of area, a pattern emerges. After some contemplation, they have identified eight apartments that well characterise what they have looked at during the past year. They write each apartment's address on a piece of paper and begin writing arguments for and against each apartment. The paper is quickly filled with comments like "great floor plan", "afternoon sun", "feels cramped", "close to school", "graffiti by entrance gate", and so on. However, by grouping those into arguments for and against, Lilly and Larry soon see that two of the apartments are out of the question. One is simply too expensive even if it looks great with a terrace and designer kitchen, and the other is so far away that commuting would take unreasonably long. The addresses of the remaining six apartments are A-street no.1, B-alley no.2, C-road no.3, D-crescent no.4, E-avenue no.5, and F-square no.6. The first three seem to be the best at first glance, but they want to continue with Stage 2 of the method with all six options without trying to decide yet. Parts of the lists from the analysis of the first three options are shown in Table 1. The other options are dealt with similarly.

A-street no.1	*B-alley no.2*	*C-road no.3*	…
Pros: Cosy living room Fido has more space Super & small school …	Pros: Fantastic terrace Own study …	Pros: Charming block Good restaurants …	…
Contras: Rather run-down area Far from town but fast access …	Contras: Big anonymous school Far from town and slow access …	Contras: Cramped room for Fido Small balcony facing north …	…

Table 1 The output of Stage 1 of the PILOT Method showing the three first options

This procedure can be described more generally. Let us assume that there is a set of lists with an easily manageable number of options, maybe five to ten. We need to develop a pro and contra list (P-C list) for each option. This list includes the advantages and disadvantages we see in each option. The lists may become relatively long, and the same aspect need not be present on all the lists. When the lists are complete, they are inspected for unacceptable drawbacks. An option with any drawback impossible to live with is rejected no matter how attractive other features of that option may be. Mark all such options and eliminate them from the continuation of the method. We now have a possibly purged set of options that we could accept as a good basis for a decision. If we intend to continue with the next stage in the PILOT model, we are now finished with Stage 1.

FINISHING AFTER STAGE 1

But if we do not want to continue with more stages and rather want to try to make a decision

already now, one finishing step remains, which is to inspect the P-C lists. Sort the pros and cons for each option. Lay out the P-C lists with all the options and weigh the advantages against the disadvantages. Try to find options that are entirely worse than at least one other and eliminate them immediately. If there are also options that are worse than doing nothing, then eliminate all of these too. Continue this process until there are only two options left. Now is the time to take a break, and upon returning, try to convince yourself (or the group if this is a group decision) that this particular option should be selected. The option of the two that prevails by that line of reasoning is the one to choose from Stage 1. We have now completed the first analysis. If that seems sufficient, do not continue with Stage 2 or any other stages (except Stage 5 if you use PM5). For example, suppose a large terrace was crucial for Lilly and Larry, but they do not care much about the school, so they select option 2, the apartment at B-alley no.2.

This may seem a bit rough and ready, and if the last part of Stage 1 seems relatively difficult, it is because it often is. This is precisely why four more stages in the PILOT Method help find the best option in a decision-making situation. However, sometimes Stage 1 suffices.

STAGE 2 - AN ARGUMENT MATRIX

In Stage 1, we produced a set of options and a P-C list with pros and cons for each. We also ensured that no options with unacceptable characteristics remained.

In Stage 2, it is time to start thinking about values. Which properties of the possible options are fundamental in this decision situation? Which perspectives on these options are the most important? These perspectives should be grouped under several criteria, each representing any focus on one or more important perspectives on the decision. The P-C lists from the previous stage are often of great help in finding these criteria. It would be strange if the pros and cons of the options did not relate to what we consider to be essential properties of the criteria we will use to make our decision.

Our example again (Stage 2): Lilly and Larry now have six apartments left, each on its own piece of paper listing its respective pros and cons. In Stage 2, it is now time to think about and decide which features and characteristics (criteria) are the most important to their decision. Lilly and Larry begin by writing these down in an unsorted list. The list is growing rapidly: “cosy neighbourhood,” “many cafes,” “lake view,” “good school for Fido,” “open floor plan,” “balcony facing south,” “good state of repair,” “close to work,” “neat indoors,” “easy to park,” and so on. It soon becomes unmanageable and Lilly and Larry try to group the desired characteristics into four main groups and one residual group of miscellany. They find this a little bit tricky, but it also affords clarity to the process to have a grouping as a goal. After some thought, they arrive at the following groupings: Area/Location, Planning/Indoor comfort, School, Commuting/Accessibility, and Miscellaneous. Both Larry and Lilly agree that these criteria embrace the most important aspects of the decision situation while some less important ones need to go into the Miscellaneous category. Further, they feel that this order between the criteria corresponds well to how important they perceive their respective criteria to be. Fido is also allowed to have his say too, but primarily so that he feels included.

The next task for Lilly and Larry is to draw up a matrix (table) with the options (apartments) as rows and characteristics (groups of criteria) as columns. They then fill the boxes with text by picking pros and cons from the P-C lists. Most of the boxes get filled, but after they have gone through and checked off all the lists, a few empty boxes remain. The last thing they do in this

stage is to complete the empty boxes by filling in their value assessments there too. Feeling quite satisfied, Lilly and Larry look at the matrix (partially shown in Table 2) to ensure they agree with its contents. They feel they have acquired a much better overview and structure for their decision. They also feel that this could be the basis for their decision but decide to subsequently forge ahead with Stage 3 in the method.

	Area/Location	Planning/Indoor comfort	…
A-street no.1	Rather run-down area Far from town but access seems fast …	Cosy living room Plenty of room for Fido …	…
B-alley no.2	Far from town and access seems slow …	Fantastic terrace Own study …	…
…	…	…	…

Table 2 The argument matrix

There are a few things to consider here. Since Lilly and Larry both think that cost is one of the most important criteria, they will use PM5 and defer dealing with cost until Stage 5. In the first four stages, they will consider each option's functional criteria and actual characteristics.

Another important point is that it has long been known that people find it difficult to simultaneously keep more than 5-7 things in their minds. For this reason, but also because in practice only a few criteria dominate most decision-making situations, they will limit themselves to four criteria (or groups of criteria), with an additional miscellaneous group for any remaining criteria, as well as an intuition criterion that we will return to later. Thus, there are six criteria in all. While this is not the method's limit, it is a general recommendation not to exceed six.

So, the purpose of Stage 2 is to find four main criteria for the current decision. If we regard the previous stage as a brainstorming process, then this stage can be regarded as a process where we ask ourselves what we really want. What do we actually value and appreciate about an option that is a candidate solution to our decision problem? Here, in Stage 2, we construct a matrix in which the options form rows and criteria form columns.

Next, we place each argument from the P-C lists in a box (row and column intersection). If an argument does not fit in any of the regular criteria columns, place it in the miscellaneous column. A test that the criteria are properly selected is that most of the arguments from the lists fit into one of the four criteria columns and that few or relatively insignificant arguments end up in the miscellaneous column. When the arguments from the P-C lists are categorised, carry out the following completion measure. One or more boxes in the four criteria columns may be empty, in which case they need to be filled in with how we value the respective options under that criterion. (The miscellaneous column need not be filled in the same way.)

After this procedure, there is a more complete basis for decisions in which all options are valued under each relevant criterion. There is now a matrix (table) with options acceptable as final choices, and which have been assessed using all the criteria. If the intention is to continue with the next stage in the PILOT Method, then Stage 2 is now completed.

FINISHING AFTER STAGE 2

But if you already want to try to make your decision at this stage, then one finishing step remains. This step is to pitch the options of the matrix against each other in a way similar to Stage 1 but with more and better-structured information. That they are already in the form of a matrix makes it considerably easier to find an option worse than all of the others (if there is one) and then eliminate it. If you find several inferior options, eliminate them all in the same way as in Stage 1. Continue this process until you only have two options left. Next, do the same as in Stage 1 and take a break. When you return, try to find convincing arguments supporting that this option should be chosen. The option that clearly wins this challenge is the option you should choose from Stage 2. If Lilly and Larry are beguiled by the living room and are happy that Fido has more space, but care neither about the terrace nor the surroundings, they should choose A-street no.1.

If you also find the last process in this stage relatively tricky that is because it is too, albeit somewhat less. That is why there are three more stages in the PILOT Method that help you find the best option.

STAGE 3 - RANKING ALTERNATIVES

In Stage 1, we produced a set of options and, for each option, a list of pros and cons (the P-C lists). In Stage 2, we continued with value assessments. Each option was valued under the four criteria that we considered most important for the decision situation. The P-C lists support this process, which we documented in matrix form (tabular form) where we reviewed each option against each criterion.

In Stage 3, we will rank all the options within each criterion separately. Usually, an option we consider the best under one criterion is not the best under all other criteria. If any option were the best under all criteria, the decision would be easy, but this is rarely the case. And in those rare cases, the best option is usually obvious without us needing to conduct any decision analysis at all.

Our example continues (Stage 3): Lilly and Larry were pretty drained after the two initial stages, which entailed a considerable effort when they needed to find a complete set of pros and cons for each of the six apartments. During the coffee break before they started with Stage 3, they speculated which of the apartments would probably turn out to be best when they were finished with the functional analysis. It is important to remember that this yet only includes functions and properties, not costs, since they use PM5. They concluded that C-road no.3 and E-avenue no.5 would probably lead, but it was impossible to say which of them had the advantage. They intuitively ranked the two options equally. They guessed A-street no.1 as the next one, followed by D-crescent no.4 and F-square no.6, with B-alley no.2 last. This order was just their gut feeling ensuing the first two stages once they had familiarised themselves in depth with their options.

Before we begin to rank the alternatives, we should, therefore, try to make use of this kind of subconscious information. Sometimes, it is not easy to completely describe a decision situation with a set of regular criteria. Even if you are relatively satisfied with the descriptions in the argument matrix in Stage 2, there may be a sense that something is missing. Sometimes there is this sense, but sometimes there is not. This will be different for people with different levels

of awareness of their thought processes and may also be different depending on the decision situation. The PILOT Method is an opportunity to ensure that all such information is exploited. You can choose to use this opportunity but it is not required. Anyone who thinks this sounds vague or does not feel comfortable with it can skip this step. Others should do the following: try to construct an overall ranking of the alternatives based on your gut feeling – what you think or guess the outcome of the functional analysis of the decision will turn out to be. This ranking is called the intuition criterion.

Assuming that various options are best under different criteria, we must rank them for each criterion. We can construct a hierarchy by studying our evaluations from Stage 2 in the matrix one column at a time. In this hierarchy, we expect to decide which options are better than which others, but a draw is also permitted and indicated by two or more options being ranked with the same placement in the order. After each criterion has been treated separately, you'll have four rankings, one for each of the four criteria, plus the miscellaneous criterion.

Our example again: Lilly and Larry have created a matrix (table) describing how they value their six prospective apartments under the six criteria relevant to this decision. Now it is time to look at each criterion separately and rate the options accordingly. They begin with area/location, the six alternative apartments are located in different areas and with different locations in these areas. Some are more centrally located, others are closer to the water. Still others are closer to the socially significant presence of cafes, restaurants, cinemas, and so on. After some discussion, they succeed in ranking the apartments. They rate C-road no.3 best in terms of Area/Location followed by E-avenue no.5 and F-square no.6, followed by the other three apartments ranked in decreasing attractiveness. Then they do the same with each of the other three criteria: Planning/Indoor comfort, School, and Commuting/Accessibility. The same apartment will not lead in all criteria. For example, C-road no.3 is the penultimate for Floor plan but is first for Area and location. Finally, they rank the remaining factors which did not fall under the four main criteria. At this stage, Lilly and Larry feel that their criteria have become stable clusters of aspects and they rename them accordingly as Neighbourhood, Floor plan, School, and Travel respectively.

Now it is time to score the rankings of the alternatives. This is entirely mechanical and involves no opinion or consideration. All that is needed is pen and paper or an Excel spreadsheet that is produced in a matter of minutes. In the matrix that contains the option rows and criteria columns, points are awarded systematically so that under each criterion the worst option gets one point, the second worst two points and so on up to the best option.

Back to our example: Draws between options are allowed, but for Lilly and Larry there are no draws in which two options are ranked the same except under the intuitive criterion. You can see their rankings in Table 3. As a very preliminary result, the options' scores are summed across the rows, which puts C-road in first place followed by E-avenue and A-street. This summary does not consider how the criteria are of different importance, but rather considers all aspects as equally important. This is not something that Lilly and Larry actually agree on. The fact that no option is best under all criteria, but rather that options, so to speak, cross over under the different criteria, means that Lilly and Larry decide to proceed to the next stage in the method. Thus, Table 3 shows the intermediate result of this stage. Note that rows and columns switch places compared to Stage 2 since this stage is a numerical one.

Stage 3	Neigh-bourhood	Floor plan	School	Travel	Misc.	Intuition	Result
A-street no.1	1	4	6	3	4	3	21
B-alley no.2	3	6	1	1	2	1	14
C-road no.3	6	2	4	4	6	4	26
D-crescent no.4	2	5	3	2	3	2	17
E-avenue no.5	5	3	5	6	1	4	24
F-square no.6	4	1	2	5	5	2	19

Table 3 Stage 3 in the PILOT Method – ranking alternatives

More generally, in Stage 3, the lowest ranked item under each criterion receives 1 point, the second-lowest ranking receives 2 points, and so on, up to the highest ranking, which receives as many points as there are alternatives. An exception is if two or more options are ranked equally under any criterion. Then they get the same score but a higher ranking will still only get one point more than the option ranked immediately below. You will now have a column with points for all options under each criterion. However, note here that we have not taken into account how important the criteria are. If you intend to do this by continuing with Stage 4 in the PILOT Method, you are now finished with Stage 3.

FINISHING AFTER STAGE 3

But if you already want to try to make a decision in Stage 3, then one finishing step remains. This step sums the options by row. We summarise each option's scores across all criteria and obtain a total. The option with the highest total is the option that the PILOT Method indicates as the best, but since we are only at Stage 3, it is good to take the results with a pinch of salt. At least retain the two or three best options and try to reason which option is preferable using a procedure similar to the previous two stages. Remember, so far we have ranked only the alternatives, not the criteria. Ranking the criteria, which comes next, is an important component of the PILOT Method. But at the 2013 EURO-INFORMS joint research conference in Rome, Don Kleinmuntz of Strata Decisions presented an MCDM decision-making software tool that was bought and used by over 1000 hospitals in the US. It contained a number of criteria that were by default set at equal weights (i.e. in essence no conscious weighting) and supposed to be altered by each hospital individually according to their particular preferences and priorities. In reality, it turned out that less than 10 of those over 1000 hospitals actually changed the weights at all (in our terminology, went beyond stage 3) and declared themselves satisfied with the decision support they had received that far. This is not to say that you should not move on to the next stage if your decision is not yet finalised, you definitely should, but rather that there are considerable knowledge gains at every stage of the PILOT Method.

STAGE 4 - RANKING THE CRITERIA

In Stage 1, we produced a set of options and developed a list of pros and cons for each option. In Stage 2, we continued by assessing the options. Each option was valuated under the four criteria we selected for the current decision situation. All this was documented in the form of a matrix in which we ensured that each option was judged under each criterion. In Stage 3, we then ranked the alternatives within each criterion so that we had as many rankings as we had criteria.

The result from Stage 3 was a scored matrix where each option under each criterion has a score that indicates exactly how this option has been ranked under the current criterion. A higher score indicates that the item is ranked higher, while a score of one point indicates that the option is ranked last of all the options under this particular criterion. However, the summation made in Stage 3 did not take into account that some criteria are more important than others. Therefore, time is nigh for ranking the criteria, not unlike the procedure we did for the options in Stage 3.

Our example again (Stage 4): Lilly and Larry have now done most of the work evaluating their options under their selected criteria. As we have seen, both of them felt that they had listed the criteria roughly in their order of importance: Neighbourhood, Floor plan, School, Travel and Miscellaneous. However, when using the PILOT Method, they need to decide exactly what their thoughts are about the criteria *in the current decision situation*. They must decide how important the different criteria are *in this particular case*.

When Larry and Lilly look at the six options, they feel that their locations are actually all quite ok. Although there are differences, they are not extremely large. The same goes for the floor plans and indoor comfort. They realise that within their price range, they will have neither a big living room nor a recently modernised kitchen, so the differences are not so great between the options they have selected and are currently considering. However, the schools in different areas clearly differ substantially, and both Lilly and Larry are keen that Fido will get a good education throughout elementary school. Larry works as an IT consultant, so he is periodically leased out to customers that can be virtually anywhere in the city. If the apartment they choose is too far from the beaten track, Larry risks having to make some very long commuting trips, and when they look again, they realise that this is an essential difference between the various options.

After rethinking this, Lilly and Larry realise that the difference between the best and worst options for the School criterion is the most important in this particular decision situation followed by Travel, Neighbourhood, and Floor plan in that order. Again, this order does not mean that Floor plan is less important than School in any absolute sense, only that Lilly and Larry have taken a stand specific to the current situation. Thus, their real criteria ranking differs markedly from what they initially thought it would be. They had not realised that such a ranking must be relative to the options – it cannot be absolute in any sense.

It is important to note two crucial differences compared to Stage 3. First, criteria are ranked only once, not numerous rankings as with the options. Second, this ranking is relative, which is a very important point, formally called the scale/weight duality. The statement "criterion A is more important than criterion B" is irrelevant in this form because we do not know what options are available under these criteria. Suppose someone says that for computer hard-disk drives that "price is more important than storage capacity". But if the prices of three disks under consideration are \$50, \$55, and \$60 with storage capacities 1000 GB, 2000 GB, and 3000 GB, the decision is completely different than if prices were \$50, \$70, and \$90 for hard drives with storage capacities 1300 GB, 1400 GB, and 1500 GB. Basically, no matter how we weigh price in relation to capacity, we choose the last hard drive in the first of these two examples and the first one in the second. To sum up, *the key is to rank the criteria according to the differences between the best and worst options in each criterion.*

In the first example, only \$10 distinguishes 2000 GB of storage capacity and in the second \$40 distinguishes 200 GB. It is these differences we must pitch against each other, not the absolute

values themselves. "Price is more important than storage capacity" is therefore insufficient information to proceed with in a decision analysis. Such a statement will lead you completely astray. When we have to rank the criteria, it is hence important to rank the respective ranges between the best and worst options under each criterion. It is exactly here that many decision-makers fail, so this stage deserves to be taken very seriously. This also entails that should you go back to Stage 3 at any point and change the rankings of options under one or more criteria, the criteria ranking in this stage must subsequently be revisited.

Our main example again: Lilly and Larry have agreed on the ranking of criteria: School, Travel, Neighbourhood, and Floor plan in that order based on the actual differences between their available options, not based on any absolute truth or order regardless of the options, simply because no such truth can exist. Therefore they assign weights as follows: Floor plan one point, Neighbourhood two points, Travel three points, and finally four points to School. Then they multiply the options' points with their respective weights and sum for each option, see Table 4. In this way, they gain an overall score for each option and that score is their complete evaluation of each option. The highest score thus indicates the option that Lilly and Larry should prefer if they had a free choice, i.e. if there were no costs involved. In Table 4, we can see that E-avenue no.5 and C-street no.3 have changed places compared with Stage 3.

Relative weights	2	1	4	3	1	0	
Stage 4	Neigh-bourhood	Floor plan	School	Travel	Misc.	Intuition	Result
A-road no.1	2	4	24	9	4	0	43
B-alley no.2	6	6	4	3	2	0	21
C-street no.3	12	2	16	12	6	0	48
D-crescent no.4	4	5	12	6	3	0	30
E-avenue no.5	10	3	20	18	1	0	52
F-square no.6	8	1	8	15	5	0	37

Table 4 Ranking criteria without the intuition criterion

In general, after ranking the criteria it is time to score them (in the previous stage we assigned points to options, not criteria). The least important of the criteria receives weight one; the next, weight two; up to the most important, which receives the highest weight. If two criteria are deemed equally important, assign the same weight as we did with points for the options in the previous stage. Once the criteria are assigned weights, sum up each option's total score as we did in Stage 3. But before summing, each option's score in the table is multiplied by the weight that each criterion received. If you have a Miscellaneous criterion in which you have a number of smaller aspects that you still want to include in the analysis, assign the weight one to Miscellaneous, otherwise assign zero.

For example, the score for A-road no.1 is calculated as $2{\cdot}1 + 1{\cdot}4 + 4{\cdot}6 + 3{\cdot}3 + 1{\cdot}4 + 0{\cdot}3 = 2 + 4 + 24 + 9 + 4 + 0 = 43$.

In doing this, something remarkable happens. From many years of research and development of decision methods, including algorithm development and simulations of all kinds of decision situations, as well as numerous real-life decision analyses, this relatively simple rating method just explained imposes a strongly discriminatory (decisive) effect on the decision analysis. One could think that specifying exact percentages for weights would be important or identifying

them more precisely should be. But a straight ranking order has proved to have properties that are close to as good - with a lot less effort. As we discussed earlier, it is generally very difficult or even impossible to give such weights with any real precision, and in such cases ranking proves to be the superior method for indicating the importance of various criteria.

The total score for each option in this process is the final ranking of the functional quality and capacity of the options being considered in the decision situation if you follow PM5 and of the entire option for PM4. Stage 4 is hereby completed, and if we follow PM4 or if there is no cost component in the analysis, then we have reached a final decision. Otherwise, we need to proceed to Stage 5.

FINISHING AFTER STAGE 4

But before we do, those who took the opportunity to set up an intuition criterion may use it now, simply by comparing its ranking with that resulting from Stage 4 in which the intuition criterion was assigned the weight zero, as in the example with Larry and Lilly in Table 4. If the rankings are consistent or almost consistent with each other, there seems to be no significant difference between the gut feeling and the formal results of the analysis. If the rankings are not consistent, there is subliminal information that partly contradicts the analysis results. Such a discrepancy does not mean that the analysis is wrong. Either the conception represented by gut feeling is misplaced, which is common, or it indicates that some criterion has been overlooked or that an option has been badly ranked. The analysis should then go back to Stage 1 or Stage 2 to see if there is any reason to re-evaluate the work of those stages. But before going back, it is advisable to check the size of the deviation. This is done by increasing the weight of the intuition criterion in increments of one until reaching five. At weight five, gut feeling weighs more than the main criterion and if the analysis still has not flipped to the expected result then we can say with great certainty that our gut feeling is playing tricks on us.

Back to our example: Lilly's and Larry's intuitive ranking corresponded fairly well with the formal analysis, but there were some small differences with options that they could not distinguish and yet which clearly differed in the analysis. Because they believe that buying an apartment is a decision that should be both close to optimal and also feel right, they choose in Table 5 to include their intuition criterion and assign it a weight of one, thus including it in the result of the stage.

Relative weights	2	1	4	3	1	1	
Stage 4	Neigh-bourhood	Floor plan	School	Travel	Misc.	Intuition	Result
A-road no.1	2	4	24	9	4	3	46
B-alley no.2	6	6	4	3	2	1	22
C-street no.3	12	2	16	12	6	4	52
D-crescent no.4	4	5	12	6	3	2	32
E-avenue no.5	10	3	20	18	1	4	56
F-square no.6	8	1	8	15	5	2	39

Table 5 Ranking criteria with the intuition criterion activated

STAGE 5 – SEPARATE COST ANALYSIS

In its larger PM5 form, the PILOT Method consists of five stages, so this is the last one. In Stages 1 and 2, we produced a set of options and evaluated each of them. Each option was evaluated under the four criteria selected for the decision situation. Then in Stage 3, options were ranked under each criterion and in Stage 4 criteria were weighted in relation to each other. The total score each option received in Stage 4 was the final ranking of the functional quality of the options. This leaves only the matter of cost to analyse in Stage 5.

Returning to our example (Stage 5): Lilly and Larry have conducted an analysis of six apartments according to the previous stage. For each option, they have calculated a monthly expense based on the monthly fee plus interest on the loans they would need to take. They calculate using a fixed rate for the next few years in order to obtain a secure budget. The cost per month for the six options is shown in Table 6.

Stage 5	Cost/month	Cost increase	Score difference	Dominance	
~~A-road no.1~~	1590	310	+24	dominated	
B-alley no.2	1280	0	0		← base case
C-street no.3	1550	270	+30		
~~D-crescent no.4~~	1490	210	+10	dominated	
E-avenue no.5	1710	430	+34		
F-square no.6	1430	150	+17		

Table 6 Trading cost and functionality

Lilly and Larry want to keep costs down, so they start with the least expensive option. They take that option as the basis of their analysis and thus make B-alley no.2 their so-called base case. In two columns in Table 6, they then work out how much more than the base case each option will cost and how many more points these have. It is possible that an option can have fewer points than the base case, which would yield a negative point difference, but this is not so in their case. Before they begin with the monetary analysis, they look to see whether any options are dominated, that is, any options that score lower in points for a higher cost than some other option. They see fairly quickly that A-road no.1 is both more expensive than, and inferior to, C-street no.3 and likewise that D-crescent no.4 is both more expensive than, and inferior to, F-square no.6. Two options can therefore be rejected before the analysis in this stage has even begun.

Starting with the base case B-alley no.2, Lilly and Larry now analyse what they can get for their money if they decide to invest more. They look at the options in ascending order of cost. For $150/month more than the base scenario, they can live on F-square no.6, which is an increase of 17 functional points. When they pitch these two options against each other, F-square seems much more interesting and worth the difference in cost, so they decide to keep it and reject the base case B-alley no.2. Next, they compare F-square no.6 to the cheapest remaining option that has not yet been rejected, which is C-street no.3. For a further increase of $120/month, a total of $270 above the (rejected) base case, they get an apartment they found to have 30 more points, a further increase of 13 functional points. Here, Lilly is a little hesitant, but Larry is more positive. After a discussion, they find that even this improvement is worth taking, so C-street becomes their new choice. There is now only one option left to consider, E-avenue no.5. At $160/month more than C-street, and a total of $430/month above the base case, they can acquire

an apartment they valued 34 points better than the base case, a meagre 4 points more than C-street. That difference between the two options does not seem that great to them, and altogether C-street appears to have the most value for money.

The decision really could only have turned out two ways during this analysis. Both of them were convinced that F-square had considerably more value for money than B-alley, but maybe Lilly could have convinced Larry that they should not have chosen C-street. Both were in complete agreement that they gained a superior overview of the decision situation by using the PILOT Method, and that with good factual arguments, it was relatively easy to arrive at the evaluation shown in Table 6 and then at a decision that they were both happy with and feel they understood.

To be a little more general, a mechanism in classical cost-benefit analysis is that costs and benefits are pitched against each other while seeking the greatest possible differences on the benefit side. And the idea behind ABC analysis in decision contexts (Analysis of Benefits and Costs) is the same. You look for the option that provides the greatest difference between functionality and costs, i.e. what colloquially would be called the most value for money. We highlighted the functionality/benefits in the four previous stages of the method and they are indicated by the sum of the points from Stage 4. In order to compare the functionality benefits to the costs, we need to find a way to compare points to monetary terms. After having rejected options that are dominated, i.e. they have a higher cost and worse functionality score than one other option, the following procedure should be followed:

- We cannot reduce the cost below the least expensive option. Therefore, we use that as the base case for the procedure. Let the cost of the least expensive option be M dollars.
- For each option, the increased cost is now calculated. If the cost of an alternative is P dollars, then the increased cost will be P−M dollars. This difference should be set against the corresponding difference for each option in the final functionality score in Stage 4 compared with the score of the base scenario.
- For each such pair-wise comparison, the most cost-effective and affordable option is retained and the other rejected.
- This procedure is repeated for each option that is still not rejected from the lowest to the highest cost.
- When all the options but one have been rejected, only the most cost-effective and affordable option remains, and that is the one to choose.

These bullet points device an approximate procedure because they contain subjective estimates of characteristics that are not easily quantifiable, but this is the method's strength rather than its weakness. It is impossible to accurately determine an objective estimate of functional points. Even if it were possible, such a procedure would take an unreasonably long time to carry out and require considerable resources. Instead, the points should be seen as stable and good indicators for the stated preferences and values, so that when Stage 5 finally pitches costs against features and functions, it does so using real costs against real functionality for the options.

Our example for the last time: After having used the PILOT Method, Lilly and Larry decide to select the apartment on C-street. The following week, they sign the contract for the apartment on the top floor of C-street no.3. Then they live happily ever after and their son Fido has a wonderful childhood and in due course a great career as a management consultant. Furthermore,

their dog Smilla avoids the crowded parks in the town centre and has access to large recreation areas.

The PILOT Method is an iterative method even if only one cycle has been described in this document. When new information arrives or the set of options change, the stages should be revisited accordingly. Feel free to iterate back to any stage at any time but remember that once a stage is revisited, all ensuing stages must be revisited in sequence before the new iteration is completed. This is especially important for the criteria ranking in Stage 4.

SUMMARY

The PILOT Method is one of the easiest decision methods that is still powerful enough, not least procedurally speaking but also in terms of obtaining stable and transparent results. It is the culmination of many years of research and development that has shifted from very powerful but also very complex methods to progressively simpler ones, both in terms of user interfaces and calculations, but without losing too much decision power. The PILOT Method has the obvious advantage of being computable by hand or very easily modelled in a computer spreadsheet. More complex methods require either advanced computational software or complex spreadsheet modelling. Thus, one can say that the PILOT Method is the most reasonable combination of simplicity and decision-analytic power available.

Note that decision analyses such as the PILOT Method can be used in two diametrically opposed ways.

- You can perform a forward analysis based on information about a number of options and their properties and try to arrive at a total ranking where one or possibly several options appear to be the most advantageous.
- Or an inverse analysis can be carried out, where the goal is to make sure that an agreed-upon decision is good enough. The inverse analysis can involve adjusting weights or other judgement values in order for the results to match and make sense.

At first glance, an inverse analysis appears a bit fraudulent since there is a danger that the parameters are adjusted to values that they would not have had in a forward analysis based on known facts. However, since the purpose of an inverted analysis is quite different, we should see the work from a different perspective. The idea here is to try to understand what led to a decision, regardless of whether that means certain parameters take on values that do not appear to be consistent with the worldview that prevails at the time of the analysis; or that of the analyst, or more generally, of the decision-makers and their environment. Through an inverse analysis, we can find out how and what is valued, in a way that in retrospect does not seem to be optimal, or if there simply are real disagreements about certain data inputs. This can be of great value, but it should not be confused with the process in a forward (‘normal’) analysis. Both analytical methods are supported by the PILOT Method and they both work in a completely analogous way. However, in this text, we have focused on the more commonly used forward analysis.

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