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Failures and successes of quantitative methods in management *

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Abstract. About 60 cases of both failures and successes of quantitative methods in management, collected in industry, business and government in the Netherlands, are analyzed for features determining either their failure or their success.

Keywords: Practice, implementation

1. Introduction

Soon after the origins of OR/MS, when the literature about the subject began to grow, a sort of hate-love relationship arose between the literature and the real world. Much of the ado in the literature never penetrates into the real world — it is not useful. Much business in the real world never penetrates into the literature — it has too little news value (mathematicians call this trivial), or too much (in view of the competition). On the other hand, the literature and the real world need each other, because OR/MS is an applied science. The area of interpenetration should be handled with care, to keep OR/MS up in the air. It is represented by the shaded area of Figure 1, which may be called the *diabolo model* of the literature and the real world. This article tries to help enlarge the shaded area.

A paper in 1965 by Churchman and Schainblatt

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- ORSA/TIMS Joint National Meeting, San Diego, 25-27 October 1982;
- Operational Research Society of India, Fifteenth Annual Convention, Kharagpur, 9-11 December 1982;
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[5] triggered off a branch of literature, which concerns itself with the interpenetration of the literature and the real world. It is called implementation research. Many authors write about a gap [e.g., 21], which may be caused by a time lag or, unfortunately, by repulsion [38]. In Germany, a shortage of empirical research was observed [29] and a large-scale remedial research project was funded which is beginning to bear fruit [30].

At least three books have been devoted to implementation research [7,14,35]; the European Working Group on 'Methodology of OR' is much involved with implementation [16,23]; Schultz and Slevin [36] started a column on 'Implementation Exchange' in *Interfaces*. Wsocki [43] describes a bibliography of 276 publications in 1979, which is progressing at an increasing speed. Milutinovich and Meli [26] review 350 publications.

Implementation research can either take the literature as its object [4,24,25,32], or the real world. An indirect view is taken by the review articles of implementation research, the surveys of the surveys, so to speak [13,26,43].

Implementation studies dealing with the real world may be based on

- a) experience,
- b) questionnaires,
- c) interviews,
- d) case studies.

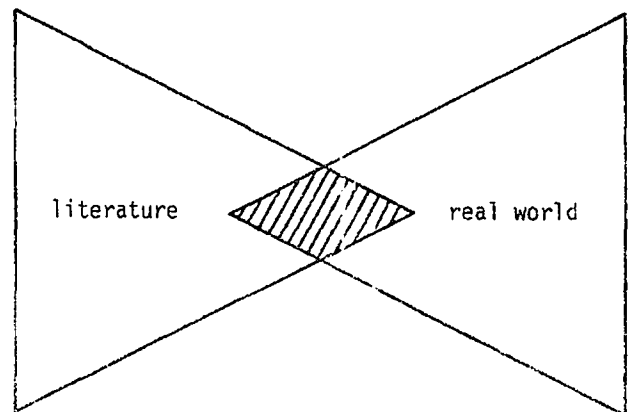


Figure 1. Diabolo model of the literature and the real world of OR/MS.

Ad a. Authors' own subjective experience is a perfectly legitimate basis for empirical studies, provided the author is an expert and an authority. Much of the vast *Interfaces* literature on implementation is based on experience [3,6,9,10,22,31,33], but also scientifically more prestigious publications accept subjective papers based on experience [5,7,12,27]. Of course, some authors speculate about more exotic paradigms, like transactional analysis [20], Zen [28] or anthroposophy [8].

Ad b. Questionnaires are often mailed, especially by Americans, to either members of OR/MS societies or firms, e.g. [19]. The problem with mail surveys, though, is probable biases of the results due to low response rates, e.g., 31% [1], 24% [11], 35% [17], 33% [37], 37% [41].

Ad c. Interviews usually have much higher 'response rates' and allow a more in-depth analysis and testing of hypotheses, e.g. [2,15,30,39,42].

Ad d. Case studies allow perhaps still more penetrating analysis of implementation problems, although their statistical significance varies. Lockett and Polding [18] analyze three case studies, Roberts [34] four, Alter 56 and Bean and Radnor 43, both in [7].

This paper is based on 58 cases [40]. The order of presentation is as follows. First the collection of 36 case studies, containing the 58 cases, is described (Section 2); next the question of biases in the samples of the cases and of the reasons for failures or successes is discussed (Section 3); then the results are presented (Section 4). Section 5 consists of a summary and conclusions.

2. 36 case studies of failures and successes

The original object of collecting between thirty and forty case studies in industry, business and government was not to do implementation research but to celebrate the 25th anniversary of the Netherlands Society of Operations Research (NSOR). The resulting collection of 36 case studies was published in a popular Dutch paperback edition and is translated by Attwood and Knoppers for an English edition by Wiley [40].

363 members of NSOR (98% of the personal membership) plus 50 Flamish-speaking members of the Belgian Society for the Application of Scientific Methods in Management (SOGESCI/BVWB) were invited by telephone to write a contribution.

This cascaded down to 200 statements of interest, 70 promises and 36 actual papers, 34 of which are Dutch and 2 Belgian.

The instructions to authors were rather rigorous. We wanted concise, well-readable, non-technical contributions of less than 3000 words (the most severe constraint). Each contribution should introduce the OR activities at the author's firm/institution and describe two cases, one of which should be a failure, the other a success. Each case should describe the problem, the approach, the results, the reasons why the results were negative in one case and positive in the other, and conclusions. It was left to the imagination of the authors to decide if a case were a failure or a success; we merely indicated that in case of a failure the costs of the project outweigh the benefits and in case of a success it is the other way round.

The reason that we obliged authors to write about a failure was that we believe that one man's fault is another man's lesson. In the literature, it might even be attractive to focus, *unlike Interfaces*, on failures rather than successes. Some potential authors dropped out because they could not find, or were not allowed to write about, a case that failed. A few others could not find a successful case! Still others had been working on just one big project in the past few years. In that case they were asked to write about the one project, but showing both sides of the medal, the partial failures and the partial successes, the trials and errors, the pitfalls and snags.

The 36 case studies received describe 58 different cases. Naturally, it was stressed for the general reader that failures and successes were supposed to occur in equal proportions in the *book*, but not in the *real world*!

After the event it was realized that the collection of cases could be used to do implementation research. This amounted merely to analyzing the reasons given for failures and successes by the authors themselves. But before we do that, we have to discuss the question of representativity of the sample.

3. Biases in the sample?

The case studies can be classified according to three dimensions, viz. according to (a) problem

areas, (b) techniques employed and (c) sectors of the economy.

Table 1 presents the number of failures and successes by problem areas dealt with. The only significant difference between the number of failures and successes seems to be in routing and scheduling.

Table 2 presents the number of failures and successes by techniques employed. Wedley and Ferrie [42] conjectured that (a) projects in which managers participate have more success, (b) managers participate more in linear programming projects, hence, (c) linear programming projects are more often successful. This conjecture is not borne out by our data. The only striking difference between failures and successes is in combinatorial optimization, probably because of the complexity of the models (cf. next section).

Table 3 presents the percentage distribution of the case studies by sectors of economic activity, compared to the percentage distribution of total labour volume in the Netherlands and of the membership of the Netherlands Society of Operations Research. The distribution of case studies over sectors corresponds fairly well with the distribution of NSOR membership, especially if one takes into account that we have discouraged academics to contribute, asking them twice if their case study concerned a real life problem and not an 'academic' problem. If we compare the distribution of case studies with the distribution of total labour volume in the Netherlands, we see that the quaternary sector, Government, and academia in particular, is overrepresented and the tertiary sector, Services, is underrepresented in the case studies. This may be partly caused by the fact that

Table 1
Number of failures and successes by problem areas dealt with

Problem area	Number * of	
	failures	successes
market research	4	5
production, inventory planning	4	6
routing, scheduling	9	4
location, allocation planning	4	6
financial, organizational planning	6	6
social, regional planning	7	7
various	2	2
	36	36

* If one project was described, it was counted on both sides.

Table 2
Number of failures and successes by techniques employed

Technique employed	Number * of	
	failures	successes
linear, mixed-integer programming	7	9
non-linear programming	1	4
combinatorial optimization	11	3
simulation	8	9
statistics	3	2
ad hoc, various	6	9
	36	36

* If one project was described, it was counted on both sides.

there are many small-scale firms in Services with too small-scale problems (cf. next section).

Our collection of case studies is far from being a random sample from all quantitative methods applied in management in the Netherlands. There may be biases in the distribution over problem areas, techniques employed, or sectors of economic activity. There may be biases in the size distribution of the firms/institutions represented, although the sizes range from the numbers 2 and 23 on the *Fortune* 1981 list of largest industrial companies in the world (Royal Dutch/Shell Group and Philips' Gloeilampenfabrieken, respectively), down to the one-man consultancy firm of Knoppers. There may be biases in the authors, approached through the NSOR membership, because the NSOR membership is dominated by its 36% mathematicians and 21% econometricians [39]. There certainly are biases due to the required 50-50 proportion of failures and successes, to the

Table 3
Percentage distribution of Dutch labour volume, NSOR membership and case studies, by sectors of economic activity

Sector of economic activity	Dutch labour volume *	NSOR membership **	Case studies analyzed
I. Agriculture	6	1	3
II. Manufacturing industry	30	21	28
III. Business services	49	31	30
IV. Government (of which Education)	15 (5)	47 (33)	39 (19)
	100	100	100

* Source: Netherlands Central Bureau of Statistics, "Labour volume by sectors and branches of industry, year averages in person-years", 1981.

** Source: [39].

requirement that cases should have sufficient news value for the readers, to confidentiality restrictions or, alternatively, to propaganda considerations (of consultants, academics).

But what really matters here is not possible biases in the collection of case studies, but possible biases in the reasons given for failures or successes of cases. Then we have to realize that the question about reasons for failures or successes was open-ended — there was no preconceived exhaustive list of reasons — and that the answers were given by the OR/MS consultants who did it, not by their managers or clients, even though the authors were obliged to admit failures. Therefore, we have to expect, and take account of, two kinds of biases in the reasons given for failures or successes:

- 1) A bias away from self-evidences to the authors, e.g. 'we had sufficient know-how, computer facilities, software available'.
- 2) A bias away from self-indictments of the authors, e.g. 'we did not have sufficient know-how, we did not sell our project properly'.

Concluding, we hardly see any reason that the biases in the sample of cases would cause biases in the sample of reasons given for failures or successes, but we expect some biases in the latter sample due to neglect of self-evidences and the fact that the judges are involved in the judgments.

4. Reasons for failures and successes

I classified the reasons given for failures and for successes independently and I realize that classifying open-ended statements from case studies is a subjective job. Fortunately, the base material is available [40], so the job can be replicated! I had expected that the reasons given for failures would be the opposites of the reasons given for successes. This turned out to be true to a limited extent.

Tables 4 and 5 present the reasons given for failures and successes. The order by which they are presented is: (a) orientation towards the client, (b) towards the OR/MS consultant and (c) towards the relation between the two, and within these orientations, roughly 'top-down'.

If we scrutinize Tables 4 and 5, some reasons for failure or success may be termed pairs of opposites, viz., F3-S3, F6-S4, F8-S5, F9-S6, F10-S7, F12-S10, F13-S11, F14-S12, F16-S14. More interestingly, some reasons do not have

Table 4
Reasons given for failures

Code	Number of times mentioned	Reason
<i>a) Client-oriented</i>		
F1	4	organizational resistance to change
F2	7	organizational changes
F3	7	data deficiency
F4	5	'data' uncertainty
F5	1	problem too complex
F6	6	problem too small-scale
	30	
<i>b) OR/MS-oriented</i>		
F7	1	project mismanagement
F8	3	progress too slow
F9	1	too much tackled at once
F10	7	model too complex
F11	5	computer-time excessive
	17	
<i>c) Relation-oriented</i>		
F12	3	lack of higher management support
F13	7	insufficient user involvement
F14	6	insufficient user understanding
F15	1	OR/MS-man involved too late
F16	15	mismatch of model and problem
	32	
	79	

counterparts, viz., F1, F2, F4, F5, F7, F11, F15 and S1, S2, S8, S9, S13. Moreover, among the pairs, it happens that one reason occurs frequently but its opposite rarely, notably, F6-S4 and F16-S14.

So much for semantics. If we now make pragmatic remarks about the results in Tables 4 and 5, naturally we refer to subjective, implicit hypotheses or expectations, either refuted or borne out by the results. Everybody is free, though, to make his own observations.

– Organizational changes (F2) are a frequent reason for failure we had not thought of. However strong the resistance to change (F1) may be, organizational changes, like reorganizations or transfers of clients, kill projects.

– Problem too small-scale (F6) rightly is a reason for failure of projects — and probably is an innumerable number of times the reason to refrain from starting a project at all.

Table 5
Reasons given for successes

Code	Number of times mentioned	Reason
<i>a) Client-oriented</i>		
S1	13	savings or profits
S2	11	improved decision making
S3	3	good (use of) data
S4	1	problem large-scale
	28	
<i>b) OR/MS-oriented</i>		
S5	3	progress quick
S6	3	step-by-step procedure
S7	9	simple, clear model
S8	5	flexible model
S9	3	good software or technique
	23	
<i>c) Relation-oriented</i>		
S10	6	support from higher management
S11	14	good cooperation with user
S12	9	model and results made plausible
S13	6	user-friendliness
S14	1	good model fit
	36	
	87	

- Project mismanagement (F7) and too much tackled at once (F9) are rare self-indictments that are supposedly underrepresented.
- Model too complex (F10) — hear, hear!
- Computer-time excessive (F11) was not expected after three decades of explosive growth of computer power.
- User involvement (F13, S11) or, what is more, user understanding (F14, S12) and ease of use (S13) are still more crucial than we had thought.
- Mismatch of model and problem (F16) was a frequent reason of failure that I could not think of naming otherwise. It was using the wrong standard 'solution' or tailoring the wrong ad hoc model. Happy consequence: there remains work to be done by OR/MS workers.
- Benefits in the form of money (S1) or improved decision making (S2) are rather tautological reasons for success — and forgotten self-evidences in the opposite case.
- Simple, clear, flexible models that progress quickly but step-by-step (S5, S6, S7, S3) — hear, hear!
- Good model fit (S14) — a self-evidence usually forgotten unless the reverse is true (F16).

5. Summary and conclusions

An analysis has been made of reasons given for failures and successes in 36 case studies, describing 58 cases, collected from Dutch industry, business and government at the occasion of the 25th anniversary of the Netherlands Society of Operations Research [40]. All authors were supposed to describe one failure and one success, and to give reasons for them.

The main conclusions from the results are:

- there is still a lot of OR/MS work to be done, building models that fit problems better;
- quick and clean work, cutting out simple and flexible models, leads to success;
- a soft, friendly approach, involving and informing the user, is crucial.

A general pragmatic recommendation ensuing from the foregoing analysis is: when implementing an OR project, try to avoid causes leading frequently to failure (given in Table 4) and try to strengthen causes leading frequently to success (given in Table 5).

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