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Analysis and meta-analysis

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Abstract

This paper gives a **traditional** review and **meta-analysis** of the literature on management support systems (MSS) success. **Based** on an extensive survey of published research in the problem domain factors, affecting MSS success are presented. Both a theoretical examination and an overview of **empirical** research of **each** factor are provided.

Correlations above $r = 0.3$ are found for user maturity of **is** department, flexibility, **realism** of user expectations, **quality** of user documentation, **formal** development, user training, management support, and user expectations.

Thus far, user involvement is the most widely investigated **variable** in empirical research. In this paper, the author **makes** an **attempt** to distinguish **objective** user involvement from user involvement as experienced by the user. Effect **sizes** for the **latter** variable **appeared** to be larger **than** findings for the **first**. Indicating that a 'feeling' of user involvement is more important **than** user **involvement** itself.

A further analysis of the data shows effect **sizes**

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for laboratory studies to be lower, and more **homogeneous** than findings of field research. **Furthermore**, correlation between the contingency factors and user information satisfaction appeared to be **higher** than **findings** which used **usage** as the independent **variable**. The relation between the contingency factors and **usage** appears to be **diminishing** over **time**. This **may** be **caused** by the **fact** that MSS less **often** fall below the level at which managers **cease** to use the system.

Keywords: *Management Support Systems, Management Support Systems Success, Meta-analysis, Evaluation, User Satisfaction*

1 Introduction

This article aims at describing the **current state** of knowledge concerning the question 'which factors influence MSS success.' In this analysis MSS are **defined** as **computer-based** information systems which **provide** 'information support for management activities and functions' [48, p. 910]. Thus research treating 'computer-based systems that are used to support managers in their decision making in planning, coordination, control, organizing, forecasting, budgeting, administration and general management' [79, p. 155] has been incor-

porated in this meta-analysis.¹

Previous analyses of research in the area of **mss success** can be found in [2, 44, 49, 101, 105]. Of these studies only Alavi and Joachimsthaler [2] performed a meta-analysis. Our study has some distinguishing features. Firstly, it covers a wider range of variables, secondly it covers more research that has been **carried out** in the field-33 studies in this analysis versus 6 studies in the analysis of Alavi and Joachimsthaler-, further our study covers more recent research. Finally we included measures of heterogeneity in our research. Thus rebuking a traditional criticism on meta-analysis.

In Section 2 the research design of the (meta)analysis is discussed. In Section 3 the findings of previous research are discussed and analyzed. Each subsection in this section starts with a theoretical **assessment** of the variable under consideration. If enough data are **available** a meta-analysis of the research **findings** is presented. Section 3 concludes with an analysis of differences in effect **sizes** between different research settings, between different dependent variables, and over **time**. The next section of the paper contains a discussion with some suggestions for further research, and **finally** a summary is given.

2 Research design

2.1 Meta-analysis

Social research has often been criticized for **lack** of results, as compared to the natural sciences. An explanation for this **lack** of results may be that researchers do not build on **each** others work [88]. Meta-analysis enables the researcher to **draw** conclusions over **many** smaller studies, using **statistical** techniques. Thus one **can** find **evidence** for effect **sizes** that normally can't be found due to too small samples. One **can** look for moderating variables explaining differences in research **findings**, and one **can** look for relationships between reported research outcomes [37, 45, 88, 102]. A laboratory experiment by Cooper and Rosenthal

¹This definition implies that no difference is made between MIS, DSS, EIS, etc. A similar way of looking at 'mss' has been discussed by Thiriez [95]. Snitkin also proposes to revise the traditional DSS notion 'on the basis of an "in use" concept' [91].

has shown that researchers using meta-analysis are more likely to report **objective** results [17].

2.1.1 The selection of literature

To **gather** the literature necessary to perform our survey the **ABI/INFORM CD-ROMS** for the periods 1985-1990 and 1989-1994 have been queried using the key words presented in Table 1. The list of titles and abstracts thus obtained was **scanned** manually for articles to be incorporated in this meta-analysis, **looking** for empirical research treating the systems **defined** in the introduction of this paper.

References of **all** read articles were **checked** for other relevant literature, and literature not yet obtained but available was incorporated in the research. Relevant articles **already** in the **possession** of the author and provided by colleague researchers were incorporated in the study as well.

Unpublished research results were not **incorporated** into the research. While the traditional argument says that published research **tends** to show **higher** effect **sizes** than unpublished research, an analysis by Rosenthal lead to the conclusion that 'There is certainly no **clear** difference between **mean** effect **sizes** obtained from journals compared to unpublished materials' [88, p. 40]. Alavi and Joachimsthaler [2] incorporated unpublished research in their **meta-analysis**, but do not report a **difference** in effect **size** between published and unpublished **findings**. Furthermore, not **incorporating** unpublished studies—which are supposed to be of lower quality than published **studies**—implicitly assigns these studies a weight of zero, thus excluding from the meta-analysis results of studies which quality falls below the **publicability**-threshold.

2.1.2 Selection of an effect size estimator

To integrate **statistics** it is necessary to bring them under a common denominator—the effect **size** **estimator**. Cohen's *d* and **Glass' A** are common effect **size** estimators in meta-analysis. Although these measures have the advantage of familiarity in **a** **context of meta-analysis**, the decision was made to use the correlation **coefficient** *r* in this study, as this effect **size** estimator is more familiar to '**traditional**' researchers. Furthermore, this **measure**



2.1 Meta-analysis

'management support system' OR		'empirical' OR
'executive support system' OR		'research' OR
'management information system' OR	AND	'quahty' OR
'decision support system' OR		'success' OR
'expert system'		'assessment' OR
		'factors'

Table 1: Key words used to query the ABI-INFORM CD-ROM for potentially relevant literature.

can be applied to both independent and correlated variables, and can be calculated directly from commonly reported statistics like *t*, *z*, and *p*, without the need to make assumptions about the size of experimental and control groups [88].²

2.1.3 Other issues

Calculation of aggregate statistics Although *r* will be used to present final results, calculations have been carried out using Fisher's *z_r*-transformation-*z*, = $\frac{1}{2} \ln \frac{1+r}{1-r}$ —which distribution more closely approximates normality than *r* itself [88, p. 21]. The unweighted average results are obtained from the arithmetic average of the *z_r*'s. Weighted average results are obtained by weighting the *z_r*'s by their degrees of freedom.

A correction of *z_r* for sample size effect is made by applying $\frac{\rho}{2(n-1)}$. In which *ρ* is the unbiased *r* of the whole population, and *n* is the sample size. As *ρ* is not available, the correction factor has been estimated in two iterations, both times substituting *r* for *ρ*.³

Treatment of dependent effect sizes Some studies report effect sizes for more than one dependent variable. Treating those dependent results as independent would result in weighting research by the number of estimates it reports [88]. To avoid this problem, the average effect size of studies reporting multiple results is incorporated in the research. When results of more than one study were

²For those who prefer to use *d* instead of *r* it may suffice to know that *d* can be converted into *r* easily by applying $d = \frac{r}{\sqrt{pq(1-r^2)}}$, which for equal experimental and control groups—*p* = *q*—equals $d = \frac{2r}{\sqrt{1-r^2}}$.

³Due to strong convergence this limited number of iterations will suffice.

presented in one paper, both were incorporated in the meta-analysis as being independent studies. This does not imply over-weighting of this studies. When a study with a degrees of freedom and a study with *b* degrees of freedom are presented in the same paper both studies will be weighted by their own degrees of freedom. If we would take the paper as a unit of analysis the average result of both studies would be weighted by a + *b* degrees of freedom.

Heterogeneity An often heard criticism on meta-analysis is that integrating studies which use different operationalizations of dependent and independent variables and different sampling units is the same as comparing apples and oranges.⁴ A example from medicine may shed some light on this issue. Take the case when a researcher on theoretical grounds has found a medicine for some till then incurable disease. In order to test this medicine one group of researchers uses tablets, another injections and a third ointments. Thus we have three different independent variables. In order to measure the success of the treatment some researchers count the number of patients still alive after three years, another groups uses the percentage of survivors after five years, still others count the number of patients who are no longer ill and a last group ask patient how happy they feel, thus we have diierent dependent variables as well. We may use their results to calculate an average effect size. When this effect size is greater than zero we know that the medicine has some effect in some situations. We have to assess the homogeneity of the effect size as well however. When we find that

⁴Glass, cited in [88] eloquently states that apples and oranges are good things to mix when we want to generalize to fruit.

the differences between the studies are only caused by sampling we know the effect size. In fact—provided that the effect size is greater than zero—we can be very confident in the new medicine as it works equally well no matter how it is applied or how success is measured. In this situation, however it is far more probable that the effect size is heterogeneous. When this is the case we will have to look for the cause of this heterogeneity. When enough research has been carried out we may be able to find that the medicine only works when applied in the form of tablets, in that case the heterogeneity is caused by the independent variables, or, when heterogeneity is caused by the dependent variable, we may find that patients live longer but do not get better.⁵ When we do not have enough data available to draw unambiguous conclusions, the heterogeneity may draw attention to areas in which more research is warranted [39].

Insufficient information Some articles do not provide all statistics necessary to derive effect sizes for the research. In one case [98] the authors explicitly mentioned the availability of complete results.⁶ Papers which only report the results of a (stepwise) regression are not incorporated in the research, as effect sizes for the individual independent variables cannot be derived.

In other, typically older, papers, the authors only indicate the significance of a relation. Such findings are incorporated in the meta-analysis nevertheless. Non-significant findings get assigned a p-value of 0.5. A p-value equal to the reported level of significance is assigned to significant findings.

3 Analysis

This section starts with a discussion of the success measures applied in the empirical investigation of MSS success. In the following subsections the independent variables, supposed to influence MSS success are discussed. To make this section surveyable the different independent variables are

arranged according to the research framework of Ives, Hamilton, and Davis [48]. They define five environments: the user, the external, the organizational, the development, and the operations environment. Three processes—use, development and operation—are deemed to be relevant for MSS success. Finally they incorporate characteristics of the MSS itself as influencing MSS success.

When enough research outcomes were available to perform a meta-analysis, the results are presented next to the paragraph. Each table presents outcomes for all studies ('total'), for studies carried out in a laboratory setting—typically a business simulation—('laboratory'), and for studies carried out in the field by administering surveys ('survey'). Furthermore, the results are analyzed by dependent variable. Three categories are distinguished: usage, satisfaction, and other measures. As one study may report results for more than one dependent variable, the number of studies reported under 'usage', 'satisfaction', and 'other', does not necessarily sum up to the number of studies reported under 'total'.

3.1 Success measures

The final aim of an MSS is to enhance goal attainment of the organization [20, 27, 50, 55, 83], or attainment of the goals of the dominant coalition in the organization [20]. This goal has to be reached by increasing efficiency and/or effectiveness of decisions and/or the decision making process [90]. Such benefits however, often are merely qualitative in nature. It is difficult, if not impossible to make these items operational [27, 32, 50, 55, 83], thus alternatives like usage of information systems [1, 8, 9, 13, 20, 22, 28, 34, 36, 68, 84, 99], more or less formal measures of user (information) satisfaction (UIS) [1, 8, 9, 10, 25, 26, 36, 46, 50, 51, 55, 61, 69, 78, 98, 99], and in laboratory settings the impact of MSS on decision making [13, 20, 99], and the influence of MSS usage on results [13, 69, 99, 103] have been proposed and applied in research.⁷

⁵Of course more complex interactions between dependent and independent variables are possible.

⁶The authors were contacted and their results were incorporated in the meta-analysis. I want to thank Mr Udo and Mr Davis for their kind and quick reaction.

⁷An exception is the assessment of DSS performance performed by Le Blanc [59, 58]. He assesses the performance of a DSS for vessel traffic coordination. His success measure is the decrease in traffic accidents. An assessment like this is only possible when the benefits of MSS are supposed to be almost infinitely high, as is the case with traffic accidents,

Ginzberg claims that task performance, **usage** and user satisfaction form a hierarchy. Task performance is the **ultimate** aim, which **can** only be achieved by **usage**. Users will only use the system if they accept it, **and** they **will** only accept the MSS if they are—at least to a certain extent—satisfied with it [35]. While **usage** and acceptance are **necessary** conditions for improved task performance, they are not **sufficient** conditions. A 'bad' system **may** satisfy the users, **may** be accepted by them and **may** be used. **However**, we **can** safely assume systems success and satisfaction and acceptance of the system to be related. This allows us to use acceptance, satisfaction and **usage** as indicators of the concept system success.

Although operationalizations of MSS **success**, like the **ones** mentioned above, **may** have their shortcomings [47, 70], a commonly accepted and applied measure of MSS success is necessary [42, 97]. Barki states that **usage** and **UIS** 'remain the best surrogates of success' [6, p. 90]. As different methods of evaluation are available, it **may** be preferable to use more than one method to **evaluate** MSS [8, 92].

Another feature of the success of MSS **may** be the realization of secondary goals. Rockart reports the example of a **CEO** who by using an **EIS** wants to **communicate** to his organization that he wants more emphasis on **quantitative** analysis in the planning and **control** process [87]. **Furthermore** an **mss** might be an instrument in **restructuring** of an organization (see for **instance** the remarks in **Section 3.2.3**). These applications of MSS have not been investigated in the **empirical** research analyzed in this article. They are not deemed to be strongly related to the quality of MSS.

User information satisfaction User information satisfaction is the most commonly used dependent variable in MSS research (see Table 9 **and** Melone [70] **who also discusses** the evolution of **UIS** instruments). **Low** user information satisfaction has been **said** to imply 'a **mismatch** between the **user's** requirements and perceptions of the system characteristics.' [47, p. 208]. The application of user information satisfaction (**UIS**) as a surrogate for MSS quality presupposes that **UIS** will be **influ-**

involving severe health exposure for the people concerned.

enced by MSS quality. Systems that better meet users information requirements and are more easy to use **will** have more satisfied users [27]. **However**, users are most likely to evaluate the system on the basis of attainment of their own goals, which **will** not necessarily be congruent with **organizational** goals. Nonetheless, Iivari and Ervasti **provide** some **evidence** that **UIS** and systems **effectiveness** are associated with **each** other [47].

The most well-known instrument to assess **UIS** is the Ives, Olson, and Baroudi [50] instrument. **However**, this instrument **has** been criticized for **lack** of some desirable **psychometric** properties—discriminant validity, **test/retest** reliability, face validity—and not including ease of use [27, 33, 97]. **However**, Doll continues 'These concerns are not widely **shared**.' [27, p. 262]. More **problematic** is the content of the instrument—general user satisfaction with **staff** and services, user **involvement/knowledge**—which not only **has** not been validated for assessing **specific** applications [27], but **also may** introduce **bias** in results **concerning** user involvement. **When** assessing the influence on user involvement this variable is both independent, **and** part of the dependent variable thus introducing an 'Easter egg **fallacy**'⁸ (a **similar** argument is made by [27]).

Usage **Usage** is only applicable as a success **measure** **when** it is voluntarily [6, 8, 9, 27, 50, 76]. Given the definition of MSS used in this paper this probably does not **cause** any problems. **However**, Ives *et al.* suggest that users **may** use an MSS known to **provide** erroneous information as a **means** of self-protection for justifying poor **decisions** [50].

Satisfaction and usage Baroudi *et al.* investigated the relation between **usage** and satisfaction. **Usage** and satisfaction **may** just be correlated **because** they are influenced by a common factor. One **may also** influence the other. By applying path analysis they conclude that satisfaction **influences** **usage** [9]. Thus the measurement of **usage** **may merely** be a proxy for the measurement of **UIS**. Zinkhan, estimated a more elaborate model using **EQS** and found **usage** influencing satisfaction [104]. Evans-quoted by [4]—**suggests** that below some

⁸Finding what has been hidden to find.

minimal level of satisfaction the user will cease to use the system. Srinivasan provides evidence that usage and UIS are not necessarily positively correlated [93].

3.2 Environmental variables

3.2.1 User variables

User characteristics may influence MSS success in two ways. Firstly, MSS may be more likely to be successful with users who have some specific characteristics than with others. Secondly, it may be necessary to match the design of the MSS with certain user characteristics. A general problem with research findings in the MSS arena is that findings of the first kind (e.g. MSS is unlikely to be successful with type x users) in reality may be of the second kind (e.g. type y MSS is unlikely to be successful with type x users) [35].

Managerial experience of user Experienced managers develop more abilities to gather and process information, thus information is more accessible to them. Hence they are more likely to use MSS [77, 98, 104]. On the other hand experienced managers might have less need for an MSS to satisfy their information needs, as they have acquired their own ways of information gathering or simply need less information, implying less expected MSS usage [62]. Alavi and Joachimsthaler aggregated the results of four studies investigating this influence. Using DSS performance as independent variables they found r to be 0.166. After correction for sampling and measurement errors they found an r of 0.206. Hence it may be concluded that managers with more work experience benefit more from MSS.

Computer experience of user Managers with more computer experience are more familiar with the ways to use a computer, the way computers function, and the limitations of information technology. This will make them feel more comfortable—having a more positive (or less negative) attitude with the MSS, hence enhancing the probability of success [46, 73, 104]. Further, it is likely that users with more computer experience have more realistic expectations which will lead to a higher probability of success. Furthermore,

more experienced users will probably find the system more easy to use [77]. Alavi and Joachimsthaler found 5 studies investigating the influence of computer experience. In their case r after correction for sampling and measurement error was 0.233, before correction r was 0.185. These results are quite comparable to our findings for laboratory research as reported in Table 2, which is not surprising considering the fact that 82% of the 33 studies incorporated in their analysis reported findings from laboratory settings.

The results reported in Table 2 do not provide convincing evidence for the hypothesis that computer experience influences MSS success. The reported correlations are low and heterogeneous. The weighted correlations between computer experience and UIS and 'other' measures even is negative. This negative correlation is caused by the study of Udo and Davis [98], which happens to be the study with the largest sample size. Furthermore, Gatian reports a small correlation for indirect users—cases in which the MSS itself is used by an assistant of the final user [32]. When we leave out both these studies a reasonably homogeneous weighted correlation of 0.2036 ($z = 2.9772$ ($p = 0.002$), $\chi^2 = 0.67$ ($p = 0.41$)) is found. However, we should be careful in interpreting this result, as no satisfactory explanation can be given for the contradictory results of Udo and Davis.

Attitude towards computers MSS, as defined above, are computer-based. Thus we expect that the user's general attitude towards computers influences the success of MSS. Both Igbaria and Nachman and Udo and Davis investigated the influence of this variable. Aggregated results are presented in Table 2. The expected influence was found by both of them and was significant, while being homogeneous.

Education of user Higher educated user will be more likely to understand the MSS and its limitations and are less likely to resist change. Besides, users who have a higher education will be more able to learn and therefore are more likely to adapt to [MSS] [99, p. 143]. Thus education will have a positive influence on MSS success. Mawhinney, on the other hand suggests an opposite, indirect effect which may attenuate the obtained cor-

	<i>n</i>	<i>d.f.</i>	<i>r_u</i>	<i>r_w</i>	<i>z</i>	<i>P</i>	χ^2	<i>P</i>
Computer experience [13, 32, 46, 68, 98]								
total	7	540	0.1114	0.0993	2.458	0.007	13.97	0.03
laboratory	1	47	0.2218	0.2218	1.551	0.061		
survey	6	493	0.0926	0.0874	2.022	0.021	13.15	0.02
usage	2	96	0.1361	0.1749	1.536	0.062	1.40	0.24
satisfaction	4	397	0.0010	-0.0149	0.021	0.508	31.81	0.00
other	2	162	0.0518	-0.0210	0.182	0.428	4.03	0.04
Attitude towards computers [46, 98]								
survey	2	216	0.2218	0.2226	3.309	0.001	0.04	0.85
satisfaction	2	216	0.2003	0.1997	2.990	0.001	0.02	0.89
other	1	115	0.2403	0.2403	2.603	0.005		-
Education [46, 68, 98]								
survey	4	315	0.0063	0.0286	0.201	0.421	2.01	0.57
usage	2	99	-0.0940	-0.0873	0.932	0.824	0.06	0.81
satisfaction	2	216	0.0512	0.0493	0.751	0.226	0.18	0.68
other	1	115	0.0922	0.0922	0.998	0.159	-	
Age [46, 68, 98]								
survey	4	315	-0.0396	-0.0578	0.859	0.195	4.04	0.26
usage	2	99	0.0248	0.0261	0.260	0.603	0.00	0.96
satisfaction	2	216	-0.1707	-0.1675	2.524	0.006	0.54	0.46
other	1	115	0.0339	0.0339	0.370	0.644	-	
Cognitive style [1, 6, 99]								
total	3	128	-0.0783	-0.0855	0.950	0.829	1.46	0.48
laboratory	2	89	-0.1097	-0.1161	1.094	0.863	1.18	0.28
survey	1	39	-0.0151	-0.0151	0.097	0.539	-	
usage	2	86	-0.0507	-0.0669	0.547	0.708	2.61	0.11
satisfaction	1	39	-0.1532	-0.1532	1.005	0.842		
Organizational level [46, 68, 98]								
survey	3	200	-0.1612	-0.1393	2.130	0.983	0.52	0.77
usage	2	99	-0.1915	-0.1795	1.888	0.971	0.19	0.66
satisfaction	1	101	-0.0995	-0.0995	1.020	0.846		
Expectations [22, 36, 86, 84, 98]								
total	6	375	0.3305	0.3033	4.953	0.000	15.97	0.01
laboratory	1	135	0.1886	0.1886	1.589	0.056		
survey	5	240	0.3574	0.3339	4.715	0.000	14.69	0.01
usage	4	252	0.3887	0.4244	4.962	0.000	23.89	0.00
satisfaction	3	202	0.2283	0.1770	2.780	0.003	3.35	0.19
other	3	147	0.2308	0.1939	2.140	0.016	3.51	0.17
Realism of expectations [8, 36]								
survey	2	69	0.3849	0.4131	3.358	0.000	1.20	0.27
usage	2	69	0.3330	0.3556	2.955	0.002	0.70	0.40
satisfaction	2	69	0.4002	0.4336	3.479	0.000	1.74	0.19
other	1	26	0.3881	0.3881	2.122	0.017		

Table 2: Unweighted (r_u) and weighted (r_w) correlation for the influence of user characteristics on **mss success**. The significance of the **findings** is reported by **z**. The homogeneity is reported **as** χ^2 . The studies integrated in the research are mentioned **after** the label. The number of studies is reported **under** **n**. **D.f.** **indicates** the sum of the degrees of freedom of the integrated studies.

relations: users with **higher** education tend to have **higher** position in the organization and hence **will** be less likely to use computers [68].

As **can** be seen in Table 2 no significant influence of education on MSS success is found. The **small** amount of heterogeneity in the total statistics is **almost** entirely due to the different dependent variables.

Age of user Age is supposed to be positively correlated with cognitive differentiation [104], negatively with computer experience [104], positively with computer anxiety—which has a negative influence on computer usage—[68], negatively with personal computer usage in general [60], and positively with managerial experience. Operating through these variables, age **will** have an indirect influence on MSS success. The direction of this effect is not immediately clear from theory, but a negative correlation is most probable. From Table 2 it **can** be concluded that age **indeed** mainly has a negative influence on user satisfaction, but has no significant influence on **usage** of the MSS.

Cognitive characteristics of user Cognitive style of the user represents the way users perceive and process information [80, 99, 105]. The number of dimensions necessary to describe cognitive style is not **clear**, but most studies use the dimensions **simple/complex**, **field-dependent/field-independent**, and **systematic/heuristic** [105]. MSS should support important managerial activities among which are problem sensing, problem formulation, and problem solution [80]. The way in which these activities **can** be supported depends on the cognitive style of the user.

Traditionally, laboratory research on the influence of cognitive style on MSS success **has** focused on the **congruence** between reports generated by the MSS and the cognitive style of the user (e.g. [5, 13, 63]). As heuristics are supposed to prefer qualitative data [99], to prefer graphics above tables, to use less data [99] and to need more flexible systems [99], Bariff and Lusk suggest to use psychological tests as a basis for MSS and especially report design [5]. In these **traditional** applications MSS success **will** be determined by the match between MSS content and the **optimal** MSS content as determined by individual characteristics [11, 105].

Another item to which **considerable** attention has been devoted is whether an MSS would be **useful at all**, given certain characteristics of the user (e.g. [13, 11, 63, 99, 104]). Persons for **whom an** MSS is less suited **may** be less inclined to use it. Thus **analytics may** accept systems which **heuristics reject** [66]. On the other hand MSS are **supposed to provide** heuristics with capabilities they **lack** themselves, thus **helping** them more **than analytics**, hence heuristics **may benefit** more from MSS and have a more favorable attitude towards MSS than **analytics** [11, 99, 104].

Furthermore, characteristics of the user have been **said** to influence MSS success **indirectly**,⁹ by (partly) determining resistance to change and **disfunctional** behaviour-aggression towards MSS or designer, projection of **mistakes** on the system, **distrust** of the system and avoidance of the system [5]. Vasarhelyi suggests a relation between cognitive style and **affinity** for computers [99].

Huber made an analysis of cognitive style research [44]. He found—deriving his conclusions partly from conference presentations by Taylor and Benbasat—that theories about the influence of cognitive style on MSS are inadequate, that measurement instruments are inadequately developed and that research design in empirical investigations is often faulty. Further he doubts whether cognitive style is of **practical** significance, as cognitive style in published research **typically** explains only 10% of total **variance**. According to Huber, this percentage will be lower in **practice**, due to reporting bias—studies where little **variance** was explained tend to go **unreported**¹⁰ [44, p. 569]—and the application of laboratory experiments¹¹ [44]. Huber discourages cognitive style research for MSS design, pointing to the **fact** that ‘development of empirical-based bodies of knowledge is painfully slow. [. . .] [B]y the time a scientifically satisfactory data base could be established, “DSS generators” **may well** be so flexible and friendly and data accessing technology **may well** be so advanced that the idea of a stable DSS design **may** be obsolete.’ [44, pp. 570–571]. Furthermore, Huber

⁹Zmud argues that there is no direct influence of individual characteristics in general on MSS success [105].

¹⁰For a **contradictory** statement see [88].

¹¹Kerlinger, on the contrary, claims that correlations in laboratory experiments tend to be lower than in reality [54]. See Table 8 for some tentative evidence.

doubts whether MSS design should consider cognitive style at all.

Alavi and Joachimsthaler included cognitive style research in their meta-analysis of DSS implementation research [1]. After correction for sample and measurement error, they found $r_{\text{satisfaction}} = 0.209$ and $r_{\text{other}} = 0.138$. Their r 's before correction were 0.167 and 0.119 respectively. These results are slightly higher than the results reported in Table 2, which are not significant. However we should be careful in drawing conclusions as the integration of cognitive style research is difficult due to the heterogeneity of the applied constructs (which confirms Hubers statement that measurement instruments have not yet been adequately developed).

Personality characteristics of the user Personality characteristics cover an even wider range of dimensions than cognitive style dimensions. 'Personality variables believed to strongly impact MIS success include locus of control, dogmatism, ambiguity tolerance, extroversion/introversion, need for achievement, risk taking propensity, evaluative defensiveness, and anxiety level' [105, p. 967].

Risk averse managers can reduce risk by gathering more information [104]. Thus we expect risk aversion to be positively correlated with MSS usage.¹² On the contrary, as the adoption of new technologies can be considered a risk, risk aversion may be negatively correlated with the adoption of MSS. After correction for sampling and measurement error, Alavi and Joachimsthaler found risk aversion to have an influence on satisfaction of $r = 0.100$ and on DSS performance of $r = 0.174$. For personality characteristics in general they report r 's of 0.124 and 0.132 respectively.

Organizational level of user Users higher in the organizational hierarchy are less likely to use computers [60, 68]. A common argument is that they will not use a keyboard as they assume this to be below their dignity.¹³ In addition, the influence of this factor will probably reduce over time

as computers become more ubiquitous. Furthermore, tasks of higher level managers also are supposed to be less structured and hence less suited to be supported by computers [68], however, MSS primarily aim at supporting management tasks.

As predicted, organizational level of the user has a significant and negative influence on usage. The influence on satisfaction, although in the predicted direction, is not significant.

User expectations of the system User attitudes—'expectations, regarding the role of MIS within the organization' [105, p. 968]—will influence the probability of MSS success [30, 46]. The motivation to use an MSS is determined by the expectancy that a particular degree of use will result in a certain quality of decision making, the perceived probability that a decision of a certain quality will lead to a certain outcome, and the attractiveness of this outcome [22] or, more simple, 'people will resist an application when the costs outweigh the benefits' [66, p. 430]. A similar argument can be made for the motivation to participate in MSS development. Users with lower expectations will tend to be less involved in MSS development, and if involved there will be less understanding between developers and (prospective) users [19]. Understanding, in turn, is supposed to be positively correlated with MSS success. Usage will depend on the expectation that the system will help one to perform her task. However, when expectations are unrealistically high the user may become disappointed in the system and cease to use MSS [36]. However, differences in expectations may be caused by a lack of understanding between developers and users. In this case realism of expectations merely is a 'reliable indicator of subsequent success or failure' [36, p. 459].

A problem with a general definition of expectations/attitude and the relation to system success is that the commonly used success measure information satisfaction also is an attitude towards the system [9], thus, by definition, the two concepts will be correlated, another occurrence of the 'Easter egg fallacy.'

The results concerning the influence of user expectations are presented in Table 2. The correlations are moderate and significant, the survey results however are highly heterogeneous. Although

¹²It is not impossible that risk averse managers overuse their MSS.

¹³On the other hand MSS—manifesting itself as an Executive Information System (EIS)—may have become a status symbol.

based on the results of only two studies, effect sizes concerning the realism of user expectations-as presented in Table 2-show high and fairly homogeneous effect sizes.

3.2.2 External variables

External organizational environment

When the design of MSS does not take into consideration the external organizational environment the scope of MSS will be limited to those situations where the organization can be considered a closed system-operational control and to a limited extent management control. To support the information needs of management MSS should both incorporate data necessary for management control and strategic planning, and match the design of MSS with the characteristics of the external organizational environment [31].

A distinction may be made between environments that are static and dynamic [31, 38]. In more dynamic environments more non-financial data will be needed by management, more frequent reporting will be necessary and more forecast information will be used [38]. Another dimension is the controllability of the environment. 'Organizations in different environments, as well as the same organization in different environmental conditions, will require different decision processes and, consequently, different information characteristics' [31, p.308]. Success of MSS is determined by the match between the MSS and the information needs implied by the environment [31, 38]. MSS that do not confirm to this mix will not be optimal. Marginal costs and benefits of the MSS will not be equal.

Furthermore, the strategic position of organizations might be an important factor. Organizations which have a high market share or some other superior strategic position are supposed to benefit more from MSS than organizations who are strategic inferior to them. In organizations with a poor strategic position MSS may even reduce managerial productivity [98].

3.2.3 Organizational variables

Organizational structure When power and responsibilities in an organization are decentralized, MSS for top (headquarters) management has

to be more sophisticated, since the top of the organizations has to be able to monitor the results of divisions [38]. Montazemi found decentralization of decision making created a need for more effective computer based information systems [72]. Ein-Dor and Segev indicate that decentralized organizations are more likely to have incompatible systems, thus decreasing the chance of MSS success [30].

Simultaneously, introduction of MSS might influence organizational structure. Evidence on this influence, however, is contradictory. Changes in organizational structure may or may not occur [85]. Ginzberg even claims that simultaneous change of organizationd structure and MSS is a necessary condition for MSS success [35]. Centralization may increase, because reliable information becomes available to higher levels, but may also decrease as MSS supplies lower level management with the capacity to handle less routine decisions. The way MSS should match organizational structure is not clear either. On the one hand, MSS may be more likely to be successful when it strengthens the organizational structure. On the other hand it may be more likely to be successful when it works opposite to the organizational structure, thus correcting for the flaws of this structure. MSS in a decentralized organization may enhance the possibilities of top management to monitor the organization without actively engaging in the activities of lower level management echelons. Centralized control increases in this situation, the flexibility, commonly associated with decentralization may be preserved. The opposite may occur in a centralized organization where MSS allows top management to delegate 'more routine decisions whose outcomes are more closely controlled' [85, p. 681]. While the organization may benefit, people who loose power-will be more closely monitored-are likely to resist implementation of the MSS, people who gain power are more likely to accept the MSS [66]. As with previous variables we might claim that the MSS and the organization should fit [35].

Size of organization Lee and Kim [61] state that the influence of organizational size on MSS success is indirect. MSS design will be more formalized in larger organizations. This formalization will lead to a higher probability of MSS suc-

	<i>n</i>	<i>d.f.</i>	<i>r_u</i>	<i>r_w</i>	<i>z</i>	<i>P</i>	χ^2	<i>P</i>
<i>Size [61, 98]</i>								
survey	2	165	0.1914	0.2382	2.725	0.003	2.16	0.14
satisfaction	2	165	0.2218	0.2793	3.167	0.001	3.39	0.07
other	1	115	0.2997	0.2997	3.255	0.001	-	-
<i>Task characteristics [34, 55, 89, 98]</i>								
survey	6	723	0.0584	0.0217	0.907	0.182	7.41	0.19
usage	1	213	0.0037	0.0037	0.055	0.478	-	-
satisfaction	5	510	0.0400	-0.0032	0.272	0.393	11.58	0.02
other	4	484	0.0267	0.0299	0.627	0.265	4.88	0.18
<i>Leadership style [46, 55]</i>								
survey/satisfaction	2	127	0.2503	0.2233	2.621	0.004	0.19	0.66

Table 3: Unweighted (*r_u*) and weighted (*r_w*) correlation for the influence of organizational characteristics on mss success. The **significance** of the findings is reported by *z*. The homogeneity is reported as χ^2 . The studies integrated in the research are mentioned **after** the label. The number of studies is reported under *n*. *D.f.* indicates the sum of the degrees of freedom of the integrated studies.

cess. This view is shared by Ein-Dor and Segev [30].

Size of organization appears to be positively correlated with mss success (see Table 3). Although the effect sizes are significant, the results are somewhat heterogeneous. We should be cautious in drawing conclusions.

Task characteristics Structuredness of a task ‘can be defined as the extent to which the procedure for dealing with management decision-making relevant to the task is routine and unambiguous.’ [61, p. 92]. The traditional view of dss is that they mainly support semi-structured tasks. However, less structured tasks tend to be less analyzable and hence the development of mss to support these tasks is more difficult [18]. Cox, Zmud, and Clark attribute this problem to a higher probability of misunderstanding between developers and users [19]. On the other hand, users performing less structured tasks may have a higher need for mss to support these tasks [89]. Sanders identified three dimensions of task structuredness: task newness, task difficulty, and task variability. Task difficulty in turn consists of analyzability and predictability [89].

Task variability—which can be considered a dimension of task uncertainty [34]—has to match with the requisite variety of mss. Hence highly variable tasks will need broader mss than less vari-

able tasks. **Tasks analyzability**—also a component of task uncertainty [34]—will influence the richness of the information needed. Thus a close relationship between task uncertainty and organizational information processing is likely [34]. Uncertain tasks will require more information. The success of an mss is determined by the match between ‘information needed’, due to task uncertainty and ‘information provided’ by the mss. Thus we expect to find a high correlation between usage and task uncertainty.

The research findings, however, show that task characteristics have no significant influence on mss success. Evidence on the influence of task characteristics on satisfaction is mixed. We should not be too surprised about this finding, as the definitions of task characteristics are rather vague, a point that is confirmed by the heterogeneity of the effect sizes.

Leadership style Leaders who have greater consideration for their subordinates and who are more likely to initiate structuring of tasks, tend to have more satisfied subordinates. It is probable that the same will hold for the management of mss [46]. The effect sizes presented in Table 3 confirm this hypotheses, are significant and rather homogeneous.

3.2.4 IS development and IS operations

IS department Lee and Kim [61] argue that older and larger IS departments are more likely to have developed a higher degree of procedural formalization, thus age and size are used as proxies for maturity. Procedural formalization is supposed to be positively correlated with MSS success, hence older IS departments are more likely to have success in developing MSS.

The position of the IS department in the organization might influence the probability of MSS success. One important aspect of this effect might be that the organization, by placing the IS department higher in the organizational hierarchy indicates the importance it attaches to this function [82].

Although the maturity of the IS department has strong effect sizes which, apart from the influence of usage, are significant, we should be careful to draw conclusions, as the effect sizes are rather heterogeneous. As can be concluded from Table 4 this heterogeneity is mainly due to the results of Joshi [51]. Without these results, effect sizes are smaller and less significant, but still heterogeneous.

Accessibility of hardware and software

Greater accessibility of hardware and software will be positively correlated with UIS [46] and usage [68, 77]. Deficient accessibility of hardware and software may cause non-use and dissatisfaction amongst users who are willing to use the system. On the same time it provides users who are not willing to use the system for instance because of a high level of computer anxiety with an easy excuse for not doing so [41].

The accessibility of hardware and software does not show a significant influence on MSS success. Although, when we look to the results for usage and satisfaction separately we see an interesting effect. Accessibility has an negative effect on usage, but not on satisfaction. We could hypothesize that unsatisfied users get more satisfied when they have a good excuse for not using the MSS.

User attitude towards IS department

Joshi mentions the influence of user satisfaction with IS staff and services on user information satisfaction. Users who are less satisfied with the IS staff and

services will mention this point as part of the evaluation of their information satisfaction [51]. Further we can imagine an indirect effect through influence on the understanding between user and developer. Joshi indeed found the predicted effect. Some care should be observed however in investigating this variable, as another occurrence of the Easter egg fallacy might be at hand.

3.3 Process variables

3.3.1 Use

Resistance to use It is too easy to simply assume that resistance to use will have a negative influence on information system success, and hence is a negative factor. However, other relevant factors may cause resistance. Resistance to use may also be a consequence of low quality of the MSS. When the MSS produces erroneous information and use would result in negative outcomes to the organization the intervenience of resistance to use caused by the low technical validity may be positive to the organization. Only if usage of the MSS is critical to the operation of the system non-usage can be called resistance [66].

3.3.2 Development

Formal development methods Lee and Kim [61, p. 90] define formalization as 'the degree to which work processes are standardized'. Formalization enhances coordination and communication between system developers and users, or among developers of specific systems. Formalization may imply strict documentation standards, which will enhance the transfer of information over time, thus leading to lower operational and maintenance cost [40]. On the other hand, excessive formalization may lead to rigidity and disfunctionality. Thus, it is not clear whether formalization will be positively or negatively correlated with MSS success. Lee and Kim however state that 'as MIS development remains unsystematic and unstructured in comparison with other organizational tasks, it is unlikely to be formalized excessively' [61, p. 90].

Formal development methods tend to be least developed in smaller organizations, smaller IS departments, younger IS departments and for tasks that are less structured [61]. When the degree

	<i>n</i>	<i>d.f.</i>	<i>r_u</i>	<i>r_w</i>	<i>z</i>	<i>P</i>	χ^2	<i>P</i>
<i>Maturity of is department [15, 51, 57, 61, 78]</i>								
survey	5	488	0.2674	0.4955	5.380	0.000	31.36	0.00
usage	1	24	0.2466	0.2466	1.186	0.117	—	—
satisfaction	4	410	0.3225	0.5695	5.175	0.000	26.49	0.00
other	3	414	0.2770	0.5086	5.538	0.000	16.56	0.00
<i>Idem, with [51] omitted [15, 57, 61, 78]</i>								
survey	4	169	0.1606	0.2020	2.265	0.012	1.86	0.60
usage	1	24	0.2466	0.2466	1.186	0.117	—	—
satisfaction	3	91	0.1835	0.1709	1.646	0.050	0.38	0.83
other	2	95	0.0948	0.2143	1.480	0.070	2.03	0.15
<i>Accessibility of hardware and software [46, 68]</i>								
survey	2	164	0.0611	0.1331	1.174	0.120	15.30	0.00
usage	1	63	-0.2476	-0.2476	2.011	0.978	—	—
satisfaction	1	101	0.3585	0.3585	3.671	0.000	—	—

Table 4: Unweighted (*r_u*) and weighted (*r_w*) correlation for the influence of is characteristics on MSS success. The **significance** of the findings is reported by *z*. The homogeneity is reported as χ^2 . The studies integrated in the research are mentioned **after** the label. The number of studies is reported under *n*. *D.f.* indicates the sum of the degrees of freedom of the integrated studies.

of formalization is **lower**, benefits of additional formalization **are higher and** the risk of over-formalization is lower. Hence, smaller **organiza-tions**, as **well** as smaller and younger is depart-ments and organizations with less**structured tasks** will benefit more **from** formalization of the devel-opment process [61].

Similar arguments **can** be made about the state-ment of **objectives**. On the one hand it is argued that clearly stated **objectives** are a necessity for successful systems development (e.g. [71]), on the other hand it is **claimed** that explicitly stating ob-jectives leads to too **much** rigidity in a too early stage of the development process. A certain **sim-ilarity** with proponents of more **and** less formal development methods **can** be observed. The same **logic may** apply as well. Clearly stated **objectives may** be necessary in organizations that have few experience in information systems. In these **orga-nizations** no system **may** be developed at all **when** the goal is not defined beforehand. On the other hand, **when** an organization has reached a certain maturity **higher quality** systems **may** be developed by allowing more freedom in the development **pro-cess**.

Only two studies investigating the relation be-tween the formality of the development method

and MSS success were found. The correlations are significant and in the predicted direction. The heterogeneity **may** be explained by the **fact** that Powers [78] only reports whether his results are significant or not, without providing an estimate of the exact effect **size**.

User involvement User involvement is the **ex-tent** to which target users have influence on **and/or** knowledge of-participate in-the design and maintenance of ‘their’ MSS [76, 105]. User involvement **can** be considered a particular **man-ifestation** of **participative** decision **making** [9, 49, 97].¹⁴ User involvement is commonly associated with MSS success, this association **may** be called **popular wisdom** [9, 10, 56, 66, 76, 94, 97, 104]. User involvement **can also** be seen as an **ethical** obligation [9].

Ives and Olson **state** that ‘user participation is

¹⁴This definition differs from the common psychological definition of involvement-‘the number of connections a manager makes between his/her own life and DSS’ [104, p. 209]. Thus it has been suggested ‘to use the term “user participation” instead of “user involvement” when referring to the assignments, activities, and behaviors that users or their representatives perform during the systems develop-ment process’ [7, p. 60]. In this paper we will use the traditional term user involvement.

	<i>n</i>	<i>d.f.</i>	<i>r_u</i>	<i>r_w</i>	<i>z</i>	<i>P</i>	χ^2	<i>P</i>
Formal development [61, 78]								
survey	-2	67	0.2468	0.3438	2.378	0.009	2.37	0.12
satisfaction	2	67	0.1607	0.3030	1.812	0.035	4.75	0.03
other	1	17	0.0955	0.0955	0.427	0.335	-	-
User involvement [1, 3, 6, 9, 10, 27, 28, 36, 51, 56, 64, 68, 76, 78, 86, 84, 94]								
total	19	2041	0.1878	0.2509	7.570	0.000	127.72	0.00
laboratory	3	114	0.1475	0.1614	2.003	0.023	1.25	0.54
survey	16	1927	0.1953	0.2560	7.382	0.000	125.42	0.00
usage	12	912	0.1649	0.1246	3.981	0.000	69.07	0.00
satisfaction	12	1499	0.3115	0.3354	9.685	0.000	47.61	0.00
other	6	455	0.1608	0.4424	4.374	0.000	24.21	0.00
User training [6, 89, 98]								
survey	5	523	0.3358	0.3203	7.390	0.000	2.38	0.67
usage	1	39	0.2531	0.2531	1.659	0.049	-	-
satisfaction	5	523	0.4051	0.3804	8.895	0.000	4.21	0.38
other	4	484	0.2675	0.2601	5.812	0.000	3.79	0.28
Management support [6, 10, 28, 61, 78, 86, 89]								
survey	9	1035	0.2225	0.3080	7.400	0.000	6.61	0.58
usage	2	548	0.2377	0.3170	5.517	0.000	1.45	0.23
satisfaction	7	518	0.3174	0.3601	7.439	0.000	6.16	0.41
other	5	394	0.1379	0.2309	3.532	0.000	4.22	0.38
Amount of change [8, 6, 98]								
survey	3	90	0.2092	0.2838	2.373	0.009	0.86	0.65
usage	2	82	0.2760	0.2760	2.617	0.004	0.00	1.00
satisfaction	2	82	0.3235	0.3259	3.047	0.001	0.26	0.61
other	1	8	0.0000	0.0000	0.000	0.500	-	-
Attitude towards change [8, 6]								
survey	2	82	0.2036	0.1898	1.705	0.044	7.15	0.01
usage	2	82	0.2151	0.1979	1.719	0.043	11.08	0.00
satisfaction	2	82	0.1775	0.1662	1.546	0.061	4.64	0.03

Table 5: Unweighted (r_u) and weighted (r_w) correlation for the influence of development characteristics on MSS success. The significance of the findings is reported by z . The homogeneity is reported as χ^2 . The studies integrated in the research are mentioned after the label. The number of studies is reported under n . $D.f.$ indicates the sum of the degrees of freedom of the integrated studies.

advocated when acceptance is critical or when information required to design the system can only be obtained from users' [49, p. 589] which according to them will be the case when designing MSS. According to Swanson user involvement only 'co-produces' MSS success. Implying that user involvement is a necessary but not sufficient condition for success [94]. DeBrabander and Edström not only question whether user involvement is a sufficient condition for MSS success, they even claim

that 'in other cases good results can be obtained without involvement of the user' [21, p. 191], thus they consider user involvement neither a sufficient, nor a necessary condition for MSS success. Part of the argument DeBrabander and Edström make is that there are different roles for users and developers in the communication established by user involvement, which will influence the probability of successful communications resulting from user involvement [21, 20]. Causality may also be in the

other direction. Users **will** not be involved in systems development, unless they **expect** the system to be successful.

Involvement **may** be linked to MSS success in two ways. Firstly, by involvement an information flow from users to developers is established. This **may** lead to better systems, which **will** imply a **higher** probability of success. Thus users are considered to possess information that is useful for the development of good systems [3, 21, 49, 64, 69, 97]. Alavi and Henderson argue that iterative or evolutionary development strategies **maximize** user input for the development process [1]. This, however, requires the manager both to have a good **mental** model of the problem situation and to be able to estimate the parameters of this model [14]. Consequently, user involvement **might** work better with **higher** grade staff [43].

Secondly, an information flow from developers to users **may** be established. Involvement **may** thus interact with other **factors** affecting systems success. Involvement **may** lead to better informed users [3, 9, 43, 49, 97], **who** are more likely to use the MSS in the right way for the right purposes [56, 97], **who** are more likely to see the **potential** benefits of the system and hence **will** have a more positive attitude towards, and more **confidence** in the MSS [43, 69, 105], and **who** finally have the possibility to enhance their own **knowledge** of their tasks by **participating** in systems design [1, 64]. User involvement **may** also **influence** the user's **perception** of the quality of the **IS** department/developers and hence indirectly **influence** user information satisfaction [51]. **Psychological** barriers to the system **may** be reduced as well. Involvement is likely to **create** users **who** have a **commitment** to the MSS [43, 49] and are less likely to **resist** the change implied by introduction [1, 3, 10, 49, 97]. To **benefit** from this advantage, one should take **care** that users **can** remember **involvement** with the development efforts, and **relate** this effort to the MSS. Thus it **may** be **necessary** to show quick results, in which case iterative design methods **may** be beneficial [64].

User involvement **can** be **measured** objectively—the amount of user involvement—and subjectively—the amount of user involvement as experienced by the user. **Objective** measures assess the information flow from user to developer, while **subjective** measures assess the

information flow from developers to the users. Research **asking** the user about the amount of involvement **will** typically **result** in the **subjective** results. **Objective** involvement is more difficult to **measure**. One possibility is to look for **operationalizations** of user involvement in the form of 'participative design methods' and 'evolutionary' and 'user initiated' development. Another more or less **objective** measure of user involvement is involvement as reported by **IS** managers. Olson and Ives report, a low and negative correlation ($r = -0.02$; $n = 83$, Cronbach's α 's for the used scales are: $\alpha_{\text{user}} = 0.85$; $\alpha_{\text{IS manager}} = 0.74$) between both measures [76].

User involvement is the most widely investigated variable in this meta-analysis. On the **whole**, 19 studies report usable effect **sizes**. The effect **sizes** are significant and in the predicted direction. **However**, only laboratory studies **reach** an **acceptable** level of homogeneity. An **explanation** for this heterogeneity is provided by Ives and Olson in their (traditional) review of user involvement research. They **state** that research designs are **often** faulty and research is not **based** on strong theory [49]. Whereas Ives and Olson conclude that research **has** not convincingly demonstrated the effect of user involvement, our **meta-analysis** **may** give food to a somewhat more optimistic **view**—not all operationalizations of user involvement are **successful**, but some are.

When we look at the influence of user involvement on **usage** and satisfaction, it turns **out** that user involvement **has** more influence on **satisfaction**, than on **usage** ($z = 2.346$ (0.025)). To test for a **difference** between outcomes of 'objective' and 'subjective' user involvement, studies mentioning 'user involvement' were **compared** with studies mentioning 'user initiated development', 'prototyping', and 'iterative development'. **Subjective** user involvement appeared to have a **somewhat** larger effect **size** than objectively measured user involvement ($z = 1.5791$). The influence of user involvement on satisfaction reported by Alavi and Joachimsthaler is comparable to our **results**—results before respectively **after** correction for **sampling** and **measurement** error are: $r = 0.301$, $r = 0.369$. **Influence** on **DSS** performance as reported by them was $r = 0.287$ and $r = 0.386$ respectively.

	user initiation	proto- typing	user involvement
studies (<i>n</i>)	2	3	16
unweighted <i>r</i>	0.0538	0.0912	0.2004
weighted <i>r</i>	0.0464	0.0936	0.2593
<i>z</i> -value	0.3966	1.056	7.647
(<i>p</i>)	(0.346)	(0.145)	(0.000)
homogeneity (χ^2)	0.02	3.89	122.79
(<i>p</i>)	(0.90)	(0.14)	(0.00)
Based on [1, 3, 6, 9, 10, 27, 28, 36, 51, 56, 64, 68, 76, 78, 86, 84, 94]			

Table 6: The influence of types of user involvement on MSS success.

Quality of training Quality of training will influence user understanding of the system. Hence it will influence the success of the MSS. Quality of training, when provided by the is department, will also influence the user's perception of the capabilities of the is department, thus indirectly influencing user information satisfaction [51].

The results for the influence of training on MSS success are reported in Table 5. All results are in the expected direction, and significant. Effect sizes are homogeneous as well. Noteworthy is the fact that the influence of training on UIS is larger than the influence on usage. However, this difference is not significant ($z = 1.0211$). Alavi and Joachimsthaler found training to have an influence of $r = 0.271$ (before correction) and $r = 0.295$ (after correction for sampling and measurement error) on DSS performance. These result are comparable to the findings for 'other' independent variables as reported in Table 5.

Management support Management support-not to be confused with management (user) involvement, which usually (see for instance [94]) means involvement of the user/manager-can be defined as the extent to which management above the level of the user—who may be a manager herself-supports the development of MSS in general and the MSS under consideration in particular. The importance of management support is popular wisdom [71]. Management support may lead to increased enthusiasm [19, 61] or decreased resistance [66] among users and may guarantee that minimal conditions-like adequate resources, both in time and money, adequate organizational

infrastructure, and good user documentation-for successful systems development and use are met [26, 61]. Management support is also supposed to be positively related to MIS staff quality [19]. It may be concluded that management support influences mss success indirectly, rather than directly. Management support is a substitute for adequate organizational procedures.¹⁵

After user involvement, management support is the most investigated independent variable. Results, which are presented in Table 5, show an acceptable level of homogeneity, which is slightly surprising, as the results of Doll suggest that top management involvement is not the relevant variable, but merely the way in which top management is involved with MSS [24]. All results are in the expected direction and are highly significant.

Change People and organizations tend to resist change [53, 66]. The introduction, or modification, of an MSS implies change; may be even more change than the introduction of traditional information technology, as the MSS has to interact with a managers decision making and thus might enforce a change of his mental model of the decision process [8] or may result in redesign of affected jobs [49].

There is little reason to suppose that (prospective) MSS users are less likely to resist change than

¹⁵This argument is the mirror of the point made by Lee and Kim, who state 'The positive influence of procedural formalization in mss development on mis success tends to be greater when top management concern is lower', implying that formalization is an alternative for management support [61].

'ordinary' people¹⁶ or that organizations are more eager to adopt an MSS than to accept other forms of change. Success of MSS will be influenced by the extent of perceived change implied by introduction/modification of the MSS and the attitudes of users towards those changes [8]. There may be interaction between attitude towards change and perceived change, thus users opposed to change are likely to perceive more change than users favoring change [8].

There will not only be a direct, but also an indirect effect. Users, being resistant to change, will tend to cooperate less with the MSS developers the greater the expected change implied by systems development is. Hence a greater degree of (expected) change will lead to lower developer/user understanding which will imply a lower quality of the MSS [19].

Understanding between user and developer When user and developer get along better, we expect a higher probability of systems success. Kaiser and Srinivasan suggest that attitudes merely should be compatible, not necessary concurrent, to achieve understanding [52]. Better understanding will lead to higher user involvement, higher quality of the final system [19, 52], and a higher correspondence between user expectations and the final system [36].

3.4 Information subsystem variables

Flexibility Flexibility is traditionally considered to be an important concept in IS in general. The results reported in Table 7 reflect this finding. Correlations are amongst the highest found in this meta-analysis. However, only 2 studies are available and results are highly heterogeneous.

Format of output The format of the output of MSS mainly has been discussed in combina-

¹⁶Keen explains 'social inertia' partly by irrationality or bounded rationality of persons who resist change [53]. It may be possible that MSS users are more rational than 'ordinary man'. In this case resistance to change amongst them may be lower. Barki even states that 'DSS users are [...] quite different from the traditional users of MIS, it then might make sense to expect DSS that bring a great deal of change to be more successful than DSS that bring less change' [8, p. 263].

tion with cognitive characteristics of the users. However, observations of the format of output sec have also been made. Researchers have investigated whether graphic or tabular output, or a combination of both leads to better results. This research, however, nowadays may seem out-fashioned, as the influence of revolutionary developments like the implementation of CRT terminals to display graphics is investigated. Another shortcoming of these studies is that they sometimes compare adequate tabular presentations of a problem with graphics that are—compared with modern standards—inadequate, and vice versa (e.g. [13]). Another problem is that some situations may be more suited for the application of graphics, while others might be more suited for the use of tabular data [12]. A match between data representation and problem enhances the quality of MSS. However, an empirical evaluation of this optimal match is very difficult. We should thus be very careful to draw conclusions too easily from these research findings, and remember that there is a rich body of literature investigating the application of the right graph or table for the right data (e.g. [16, 29, 65, 100]).

Expectations of 'format-of-output-research' are that the use of graphics will lead to faster decision making, to a better understanding of the problem situation [63], and to better decisions [63], the use of graphics and tables together will lead to still better decisions [63]. Benbasat proposes to conduct a number of laboratory experiments within a great variety of task settings [12].

Interaction effects include that heuristics prefer graphics and their decision making will benefit from them, while analytics will prefer tables [13, 12, 63]. An important set of research findings in this area are the so-called Minnesota experiments. These laboratory experiments investigated the influence of different system characteristics like complexity, the application of CRT's and presentation of data. A summary of the results of these experiments has been presented in [23].

Quality of user interface Raskin discussed intuitive user interfaces, concluding that what is usually called 'intuitive' merely means familiar, remaining close to the cognitive world of the user—the status quo—, thus leaving little room for im-

	<i>n</i>	<i>d.f.</i>	<i>r_u</i>	<i>r_w</i>	<i>z</i>	<i>P</i>	χ^2	<i>P</i>
<i>Flexibility [6, 98]</i>								
survey	2	154	0.5088	0.4386	5.669	0.000	3.92	0.05
usage	1	39	0.5673	0.5673	3.707	0.000	—	—
satisfaction	2	154	0.5619	0.4870	6.274	0.000	5.12	0.02
other	1	115	0.3546	0.3546	3.852	0.000	—	—
<i>Quality of user documentation [25, 26, 96]</i>								
survey/satisfaction	3	542	0.3775	0.3881	8.401	0.000	4.12	0.13

Table 7: Unweighted (r_u) and weighted (r_w) correlation for the influence of information subsystem characteristics on MSS success. The **significance** of the findings is reported by z . The homogeneity is reported as χ^2 . The studies integrated in the research are mentioned **after** the label. The number of studies is reported under n . *D.f.* indicates the sum of the degrees of freedom of the integrated studies.

provement of the interface, ‘even **when** it **can** be shown that a feature that is completely familiar (intuitive) is deficient’. ‘That quality of a new interface **paradigm** that is commonly titled “**intuitive**” **may well** turn out to be one of the worst qualities it **can** have’ [81, p. 18]. Bénard and Şatir found spreadsheet-like functionality to have a **positive** influence on user satisfaction [10]. The **traditional** EIS user interface might be too simple. Managers, **who** are supposed to be adult and intelligent, are sometimes supplied with with user **interfaces** that seem to be suited for ten year old children.

Quality of user documentation Good user documentation not only **trains** the user, but **also** **has** an educational function. It explains the user why the MSS is suited for which purposes. **It** helps the user understand **how** the MSS works **and how** to use it [25, 26, 33]. The quality of user **documen-**tation is defined as the degree to which it **commu-**nicates this information to the user efficiently and effectively [33].

Thus a certain miniiial quality of user **docu-**mentation **may** be necessary to make sure the sys-tem is used at **all**. Better user documentation allows users to use the system more **efficient**—thus possibly decreasing **usage**—**and effective** [40]. Good documentation **may** allow to spend less on training and user assistance [40]. It enhances communication from systems developers to users [26, 40]. It is expected that better user **documen-**tation **will** increase **mss** success through increasing user information satisfaction [33]. Doll even notes

that it **may well** be possible that the success of spreadsheet packages which allow users to build their own MSS **may** be explained by the **availabil-**ity of adequate manuals [25]. Lee found **PC** users not to be satisfied with their user documentation [60]. Guillemette’s findings partially support this conclusion: users rated documentation of **pack-**aged software as more appealing **than documenta-**tion of internally developed software. The **latter**, **however**, they found more convincing [40].

User documentation potentially is **an** important factor in establishing MSS success. **Results** are in the expected direction, and are highly significant. **However**, effect **sizes** are not as homogeneous as one would hope. More problematic is the **fact** that the studies are not independent. **All** papers are (co)authored by Doll. This **fact** might introduce some bias.

3.5 F’urther analyses

The data **obtained** from the meta-analysis have been analyzed to investigate whether other **avail-**able characteristics of research have some influence on obtained results. This was done by analyzing the **absolute** values of the effect **sizes**.

Laboratory research has been compared with survey research—see Table 8. It is not only **note-**worthy that laboratory research yields smaller **av-**erage results ($z = 1.858$), but **also** that these **re-**sults are **quite** homogeneous: **all** laboratory re-search **tends** to find **an** effect size from the same population. Of course we should be careful to **draw** conclusions as the number of laboratory

	<i>Laboratory</i>	<i>survey</i>
studies (n)	6	33
<i>d.f.</i>	276	4222
unweighted <i>r</i>	0.1845	0.2579
weighted <i>r</i>	0.1888	0.2891
<i>z</i> -value	3.173	14.591
(<i>p</i>)	(0.001)	(0.000)
homogeneity (χ^2)	0.29	109.55
(<i>p</i>)	(1.00)	(0.00)

Table 8: The results of survey research and laboratory research compared.

studies in this meta-analysis is small. Furthermore, the effect sizes for usage, satisfaction and other dependent variables were compared. The results are summarized in Table 9. All effect size are fairly heterogeneous, which in this case is a desirable property. Outcomes for satisfaction show larger effect sizes than outcomes with usage as the dependent variable ($z = 2.5119$). The other independent variables are somewhere in between. The weighted results exhibit effect sizes of about the same size as the effect sizes for satisfaction. The unweighted results are much smaller however. Overall these results suggest that field studies using *uis* as an dependent variable are most promising to pursue.

The influence of time on effect sizes has been investigated as well. Time influences neither the overall effect size ($z = 0.5719$), nor the effect size with satisfaction as the dependent variable ($z = 0.6923$). There is a negative correlation

	<i>usage</i>	<i>satis- faction</i>	<i>other</i>
studies (n)	17	27	13
<i>d.f.</i>	1817	3042	1135
unweighted <i>r</i>	0.1594	0.2602	0.1683
weighted <i>r</i>	0.1647	0.3036	0.2821
<i>z</i> -value	5.407	12.807	6.032
(<i>p</i>)	(0.000)	(0.000)	(0.000)
homogeneity (χ^2)	98.28	93.48	59.76
(<i>p</i>)	(0.00)	(0.00)	(0.00)

Table 9: The results of different dependent variables compared.

($r = -0.1911$) between effect sizes with usage as the dependent variable and time ($z = 4.6240$). A possible explanation might be that over time fewer systems fall below the threshold where users cease to use the system. A positive development of the effect size reported for the other dependent variables can be seen ($r = 0.3851$; $z = 3.6918$). Causes of this tendency may be twofold. First, more survey and less laboratory research is carried out. Second, the research carried out is based on a better theoretical basis, hence increasing the change that research will be carried out in a fruitful direction.

4 Discussion and suggestions for further research

In this paper an analysis has been made of previous *MSS* research. This analysis allows us to gain new insights in our problem domain. However, not all research could be incorporated in our analysis. One reason is that researchers do not always give adequate information. In order to facilitate further analyses of their data researchers should take care to publish covariance matrices and sample sizes along with their research findings. Editors can encourage such practice.

Quite a number of variables investigated in this analysis show heterogeneous effect sizes. A possible cause may be that the interrelationships between variables vary during the systems development and introduction process. A solution for conflicting outcomes might be to focus more research on process, instead of factors [35, 74]. Newman proposes an approach related to the evaluation of services (*SERVQUAL*) in marketing research [74]. Heterogeneity may also be due to the fact that measurement instruments in information systems research are of relatively low quality. Hence it is not always clear whether the instruments measure the constructs they are supposed to assess [70]. The development of high-quality measurement instruments is a critical research priority [27, executive summary]. In some cases however the construct to be investigated should be more clearly defined. Results in the case of user involvement—see Table 6—show that this kind of research may be worthwhile. Another solution for the ‘prob-

lem' of heterogeneity might be found in carrying out research in which not only the direct influence of contingency variables on MSS success is investigated, but also the match between different contingency variables and MSS design as suggested by [35, 67]. Results for the realism of user expectation-which is an instance of matching—suggest that this approach may yield useful results.

Not all variables have been investigated empirically. The external environmental variables influencing MSS design have only be subject of theoretical research. Only their derivative—task characteristics—which are influenced by environmental characteristics—has been the subject of empirical research. However, only a limited amount of work has been done in this area and the definitions for task characteristics applied in this research show some heterogeneity. The area of personality characteristics also shows a lack of research findings. Particular the external environmental variables may be suited for further research.

Another point that deserves more study are factors for which high effect sizes were found, but where more evidence is needed. Especially 'quality of user documentation'-which has only been investigated by Doll-and 'flexibility'-which surprisingly has only been investigated twice—are candidates worth further research.

A general problem in the research findings is that only a limited variety in success will be found. Systems of which the quality falls below a certain threshold will soon be 'forgotten' and will not be incorporated in survey research [8]. Thus certain variables may not be traceable by traditional research methods at all.

Finally, more research investigating both direct and indirect influences of the contingency variables and interdependencies amongst them may lead to interesting results. Particular in cases where opposite direct and indirect influences are expected this approach is necessary. Structural equation modeling-using LISREL or EQS-is the suited methodology to investigate the direction of causality in the relations between the different factors, and to distinguish the direct effects of a factor on success from the indirect effects of and via other variables. A good example is the study by Zinkhan [104].

variable		
maturity of is department	0.4957	*
flexibility	0.4386	*
realism of expectations	0.4131	
quality of user documentation	0.3881	
formal development	0.3438	
user training	0.3203	
management support	0.3080	
expectations	0.3033	*
amount of change	0.2838	
user involvement	0.2509	*
size of organization	0.2382	
leadership style	0.2233	
attitude towards computers	0.2226	
attitude towards change	0.1898	*
organizational level	-0.1393	
accessibility of HW/SW	0.1331	*
computer experience	0.0993	*
cognitive style	-0.0855	
age	-0.0578	
education	0.0286	
task characteristics	0.0217	

Table 10: A global summary of the research findings. Reported is the weighted correlation between the independent variable and the success measure. The same results have been labeled 'total' in prior tables. An * in the final column indicates that the null-hypothesis of homogeneous results was rejected at $\alpha = 0.05$.

5 Summary

In this article the state-of-the-art in MSS research has been assessed. Theoretical considerations about the predicted influence of numerous contingency variables from previous research have been summarized. When possible, an objective investigation of the validity of these theories has been made by applying meta-analytical techniques.

Attitude towards computers, user expectations, realism of user expectations, size of organization, leadership style, maturity of is department, user involvement, training, flexibility of the MSS, quality of user documentation, management support for MSS, and application of formal development methods showed positive and significant results. The amount of change implied by the introduction of MSS, and organizational level of the user had a

significant and negative influence on MSS success. The influence of education, computer experience, age, task characteristics, accessibility of hard- and software and cognitive style showed mixed and/or insignificant results.

Correlations above $r = 0.3$ —called 'moderate' by Nunnally [75]—were found for user expectations, realism of user expectations, maturity of IS department, the application of formal development methods, user involvement, training, management support, the amount of change, and the quality of user documentation. For practitioners it may be encouraging to note that a number of these influential variables is controllable.

User involvement was the most widely investigated variable. An attempt was made to distinguish objective user involvement, and user involvement as experienced by the user. Findings for the latter variable appeared to be larger than findings for the first.

A further analysis of the data showed findings for laboratory studies to be lower, and more homogeneous than findings of field research. Furthermore, correlation between the contingency factors and user information satisfaction is higher than findings which used usage as the independent variable. The relation between the contingency factors and usage diminishes over time. This may be caused by the fact that MSS less often fall below the level at which managers cease to use the system.

Both heterogeneity of findings and a lack of findings for some variables call for further research. In the latter case more research is needed. In the first case more refined research is needed.

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