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Project management by early warnings

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Abstract

The increasing turbulence found in the corporate environments today and concurrent engineering as applied to project-related activities, there is growing demands on the flexibility of project management and the ability to anticipate the future. The conventional methods of project control are not really capable of rising to these challenges. The early warnings observed in project-related activities or the weak signals as described in Igor Ansoff's theory enable project managers to better anticipate and manage otherwise unforeseeable project problems. This article explains the character of the phenomenon and some other related factors. It shows how early warnings relate to project problems and their causes, and develops a preliminary model for the utilisation of early warnings. The article is a continuation of an article published in the Internation Journal of Project Management Vol. 15, No. 6 in 1997.

Keywords: Project management; Symptom; Early warning; Weak signals

1. Background and a possible solution

Corporate management today is adamant about not yielding to changes in project plans. Due to the economical pressures and turbulence in the corporate environment, industrial construction projects have to be implemented in less and less time, often using the principles of concurrent engineering. Project managers must be able to adapt to great changes when market-related forces lead to such demands in the middle of a project. These forces set more and more growing demands on the project leader's ability to react to "unforeseeable" events. He/she should be increasingly capable of anticipating the future progress of a given project. Conventional methods of project management cannot properly address to challenges of this nature.

In 1975, business economist Ansoff [1] claimed that sudden changes in a company's environment, affecting the activities within the company are at first identified as very vague "weak signals" which usually become stronger and more specific in time. He has also presented his ideas for utilising weak signals in corporate strategic management. Using various names, the idea of weak signals has been applied quite extensively in business economics, especially in the field of strategic planning and management, by developing various management models for the business environment. The research carried out in the fields of communication [2], military intelligence [3,4] and business economics (anticipation of bankruptcies) [5] encounters the idea of weak signals and early warnings. Project-related literature includes only allusions to similar weak signals, by the names early warnings, symptom, early indicator, presignals etc. However, the meanings of all of the above are essentially the same.

This article presents one possible answer to complete the methods of project management in use today. The idea and the model presented is not intended to replace any proven conventional methods. Instead, it aims to add to management and leadership an element of anticipatory action, which could speed up reaction to problems threatening a project.

2. Conventional methods of project control

The conventional methods of project control are based on what has already taken place, i.e. so-called historical information. They use trends to predict future

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events. Using trends, it is difficult to perceive unforeseeable changes or situations that are surprising or develop outside the scope of project plans. All such conventional methods adhere to the principle of so-called deviation management. The situation becomes even worse if the project manager is willing to take action only after observing large deviations, such as delays of several weeks in a time management report. Also, the methods do not address the problems relating to actual leadership (human and culture) at all.

Cost reporting gives the project manager an idea about the cost situation at the time of reporting. It addresses only to cost-related matters and forecasts the end result of the project. Conventional methods of time management include: bar chart schedule with break-line, schedule (time) performance, work performance, the earned value method and the cost/schedule control systems criteria (C/SCSC) guidelines. They all concern themselves with project events; on leading projects on the basis of facts. The methods are informative in nature, unless they are used in conjunction with rescheduling based on the critical path method (CPM) principle. The event forecasters, that work the best in a practical working environment, are forecast schedules implemented using the CPM or program evaluation and review technique (PERT) principles [6,7].

3. Project risk management (PRM)

Risk analysis and risk management have been popular subjects for research, articles, specialised literature and conferences during the 1990s [8–11]. Today's project risk management aims at proactive project management, which is also an objective of this study. PRM is a very important task during project planning and project control. The most popular computer programs used for project risk management are still somewhat primitive. They have not yet been developed into commonplace tools of project management in the same way as time management programs have, for example [12]. Essentially, almost all methods of risk management, presented in the literature on project management and commercial risk management computer programs appear to favour one-time identification, evaluation and analysis of risks. These methods do not seem to favour simple, quick risk analyses and demand a great deal of work. Commercially distributed programs mostly deal with the probable project outcomes. Commercial PRM computer programs fall into two primary categories, which are (1) risk analysis oriented programs such as @RISK, OPERA and CRYSTAL BALL; and (2) programs supporting PRM processes such as FUTURA and TEMPER SYSLA. Risk analysis does not necessarily reveal whether a risk is really becoming a reality but states the risk's level of seriousness, its effect on the project and the probability of its realisation. Also, risk analysis often remains a one-time procedure at the beginning of the project with very little true risk management being carried out during the course of the project.

4. Research at the Helsinki University of Technology (HUT)

In the HUT's Department of Industrial Engineering and Management, a study [13] was conducted on early warnings occurring in industrial construction projects and how to take advantage of this phenomenon. First, 17 project professionals were interviewed (basic material, 1993). Further research examined project problems observed in four case projects (case material, 1995) and sought to find early warnings which pointed to the problems by interviewing representatives of parties participating in the projects. The study was conducted according to the qualitative research principle, utilising the so-called thematic interviewing method [14]. The study includes an analysis of 68 basic types of early warnings and out of them, 11 main type groups. It also lays out the typology of the phenomenon and seeks to isolate the project problems they point to and the possible basic causes of the problems. Table 1 presents the basic groups of early warnings found in the study and their main groups (bold), including short descriptions of the early warnings [13].

The study found that observations conforming to the idea of early warnings can be made frequently in project activity environments. The warnings are in part information input (signals and stimuli) phenomena in accordance with Wiio's [15] "A System Model of Information and the Information Process" and in part clear communicative messages. Communicative warnings are surprising, contain a change in relation to the earlier situation and are always tied to the interpretation made by the receiver [16]. The warnings typology developed during the research indicates that the warnings were observed to occur in all project phases (planning, procurement, delivery and site activity), deliver information on all parties of the project, and are manifested in many ways (verbally, non-verbally, in writing, as events), with the sources being humans, groups of humans, companies, documents and situations. Concerning the (in)exactness of the information, the warnings brought up by the interviewees can, by and large, be located on the state of knowledge scale presented by Ansoff [1]. According to Wiio, the accuracy of the information obtained is very subjective [16]. It was found that the observer is unable to interpret obtained information in a meaningful way if there is an attempt to remove the signal from the environment in which it was observed. Project conditions are part of the informative content of the signal (see [17]).

Table 1
Early warnings groups analysed from the material, with short descriptions [13,18]

Early warnings	Percent share basic (%)	Percent share case (%)	Description
Gut feelings	4.7	2.6	Anticipatory feelings are the signals the least easy to detect, identify and interpret. intuitive feeling
Personnel, project group	38.2	21.7	
Non-verbal information	3.8	1.4	Various non-verbal messages observed in meetings are the most important signals of reference for the negotiators in meetings
Personnel behavior	15.7	14.2	A large group of various behaviors
Personnel behavior in general	2.3	4.0	'Abnormal' or inconsistent behavior of the contractor/supplier almost always means trouble for the project
Mood, attitude	1.7	4.7	A mood of non-satisfaction in the Personnel
Conflicts	2.6	3.5	Conflictive situations
Talking behind the back			Talking behind the back (unnecessary criticism)
Indecision			The organization is stalling the progress of the project
Frank talks			Lack of trust expressed in no uncertain terms
Commitment	1.7		Weak commitment to the project expressing itself in many ways
Cliques			
Authority disputes			
Making excuses			Typical to consultants, but not rare for contractors either
Lack of contact with the client			A phenomenon specific to each project
Unrealistic Planning			When it becomes obvious that Planning cannot meet all the requirements
Lack of resources		3.1	A lack of working staff noticed
Changes in Personnel			A "phenomenon" especially common to consultants; changes in project Personnel
Professional skills			The professional and project-related skills of Personnel
Project manager, management	1.2	8.3	
Project manager as a person			The personal qualities of the project manager
Management style		6.1	
Project planning	4.5	13.0	
Preliminary plans		3.8	The level and quality of preliminary plans
Project plans			Inadequacies in project plans
Tender material			Deficiencies and insufficiencies in tender material
Contract		5.7	A contract drawn up unprofessionally or unambiguously
Contract with issues			A contract consciously drawn up to have little room for changes
Budgeting, budget contents			The budget has been poorly drawn up, the basis is insufficient and the budget is undersized
Advance material			Reference material
Project control and reporting	6.8	5.0	
Progress control	3.1	3.5	Classical schedule-based monitoring of progress
Monitoring	2.8	1.4	Classical methods of project activity
Monitoring in general			
Availability of materials			The contractor's (or the supplier's) ability to acquire materials
Working level, quality and speed			Speed and quality of work at the site
Budget corrections			Tendencies to change the budget without proper reason
Working within the project	7.7	10.4	
Work initiation	3.5	0.7	The efficiency of initiating work, its sluggishness is often revealing
Mobilization			Mobilization at the work site, slow initiation of work, and/or poor turnout at the site
Initial information/lack of information	3.0	6.9	Lack of initial information for Planning, their being late is very typical in projects
Same things repeatedly			If the same things come up again and again in meetings etc
Organization type		2.4	
Communication	7.8	5.2	
Communication	4.9	2.6	
General miscommunication			Messages lost along the way
Tone of messages			The tone of messages, especially when it changes, suggests that something has happened

(*continued on next page*)

Table 1 (*continued*)

Early warnings	Percent share basic (%)	Percent share case (%)	Description
Letters			Writing letters
Conflicting knowledge			Conflictive information
Insinuation	3.0	2.6	Many problems detected due to insinuation. People are not willing to say things straight out
Expressed by parties	8.9	9.2	
Typical to client	7.1	9.2	
No decisions	2.6	4.0	Delayed decisions, especially those caused by the client, is one of the worst factors causing problems in projects
Trust disappears			A third party notices the problem
End users		2.4	Late recruitment of production Personnel (staff)
Freezings			The "no decisions" group also includes not being able to "freeze" the design principles
CEO			No support from the company CEO for the project
Additional research			Very typical during a brand tendering phase
Procurement			Matters relating to procurement, delays etc
Supplier/Contractor	1.7		
Advance billing			Willingness for advance billing may be manifest already as Planning factors in negotiations or as a request for change
Documents	11.0	9.9	
Reporting	2.6		Quality, tone and lateness of reports are revealing factors
Schedules: level/quality/receiving	5.4	4.3	
Symmetry Being logical			The level of the schedules can be estimated on the basis of the "symmetry" and readability
Receiving/Level			How quickly a contractor will deliver schedules after reaching an agreement
Technical plans		4.3	Changes in plans, especially when there are lots of them, become warning signals
Incorrect revisions			Old drawings turning up at the site is a sign of communications problems
Responsibilities unclear			This situation relates to organizational problems
Differences and deficiencies in project culture	4.0	9.2	
First contact (to client)			First impression and the observations in first contact between parties are a good source for signals in the opinion of the interviewees
First impression			Observations made during meetings with the client
Project terminology			Differences in project terminology or low proficiency in the terminology reveal inexperience with projects
Lack of experience		3.8	Inexperience is revealed quickly and in many ways
American culture		2.6	A phenomenon specific to each project
External source	2.4	1.2	External sources; insinuation, may include unambiguous numerical data
No early warnings obtained	2.8	0.5	It is difficult to observe early warnings
Small groups and scattered signals		3.8	
Total	100	100	

5. The nature of the phenomenon

Fig. 1 illustrates the nature of the early warnings phenomenon and its relation to project events. The picture illustrates the factors relating to the phenomenon. In the picture, a project is depicted as a chronological flow of events, from which an observer obtains information. The human observer makes observations, receives communication and messages. He/she may use various methods to obtain the desired information. The observer accepts and interprets the information obtained. This is the phenomenon's communicational phase which is tied to the human observer.

The second phase of the phenomenon can be considered to be the analysis of the information obtained and decisions made on the basis of the information obtained. The process also often involves a decision-maker. Activities in projects always have to do with upcoming events, the future. The nature of the phenomenon proposed by Ansoff in his theory of weak signals is different in the project environment. Ansoff requires companies to gain most of their information from their corporate environment. In projects, most of the information seems to come from within the project, with only a smaller part of it coming from the outside.

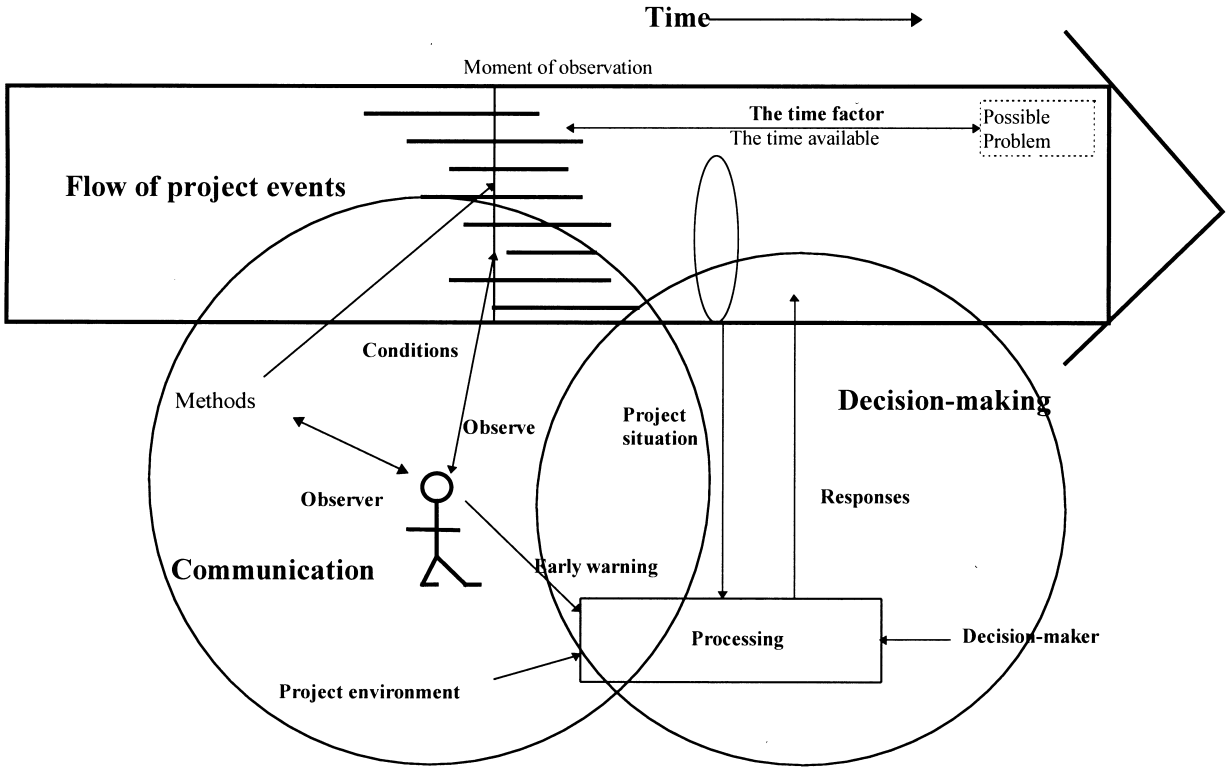

Fig. 1. The early warnings phenomenon in a project environment [13,18].

6. Project problems, their causes and responses

To make effective use of the phenomenon is most fundamental to relate an early warning to appropriate project problems and their causes. One must also identify the countermeasures to be undertaken in each case. It is important to know the interdependencies of these concepts. Fig. 2 presents the hypothetical dependencies between early warnings, project problems, causes of problems and responses (decisions to result in correction).

Tables 2 and 3 [13,18] present the project problems that came up in the study, their causes, and their percentage distribution in the material. According to the material, four project problems account for 54% of the observations in the material derived from the basic interviews and for roughly 84% in the case material: "schedule-related problems", "problems relating to delivery of equipment" "total management problems" and "problems related to technical design". Three causes for problems stand out from the basic material. They are: "differences in project culture", "personnel skill and talent", and "multiple (more than three) reasons". They account for roughly 57% of the observations. The dominant causes for problems in the case material are: "management methods" and "differences in project culture". They account for about 52% of the observations. Because the questions used in the interviews were drawn up with problems in mind, one should not use this to make any conclusions on how common different project problems and their causes are in projects.

Tables 4 and 5 present the most frequent combinations of warning signals–project problems and problems–causes of problems found in the material [13,18]. The total material suggests that "the warning signals expressed by personnel" are obtained from within all of the problem groups. Also, it is significant that the interviewees have observed "gut feeling" in the context of very many problem groups. Left out of these tables are many significant combinations, all of which account for at least 1% of the observations. In the material, the Pareto principle [26] (the 20/80 principle) is found to be at work. Table 4 contains combinations with an observation count of over 1% out of the total number of observations account for 16% of the number of combinations. They account for roughly 69% of the observations.

Table 5 appears to stress the same problem groups as Table 4, and the causes of problem stressed are:

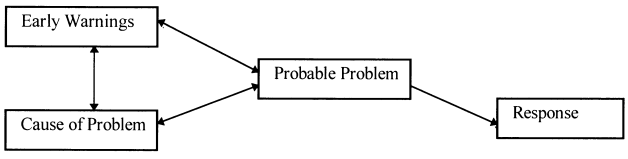

Fig. 2. The hypothetical dependencies between early warnings, project problems, causes of problems and responses.

Table 2
Project problems, main groups [13,18]

Project problems, main groups	Basic material (%)	Case material (%)
Schedule problem, delay, time	19.0	9.5
Cost-related problem	5.3	5.0
Delivery problem, performance	8.8	24.8
Project environment, consultant	1.7	2.9
Goals unclear	1.9	
Client with, no CEO support	0.8	
Total management problems	18.8	22.2
Project manager as a person	3.5	3.3
Organization/Staff	2.1	0.6
Total staff problems	7.1	2.1
Total project planning	5.7	
Communication	5.0	0.8
Design, technology Planning	7.4	27.9
Financial matters	6.1	0.6
Differences in project culture	4.3	0.2
Non-definable	2.8	0.2
Total	100	100

Table 3
Causes of project problems [13,18]

Causes of problems	Basic material (%)	Case material (%)
Attitude-related	5.4	8.1
Management methodology	9.4	15.2
Project manger as a person	4.2	5.4
Differences in project culture	13.4	36.7
Organizational reasons	8.2	6.5
Personnel skill and talent	14.1	4.4
Lack of resources	8.7	9.6
Financial matters	5.7	9.4
Multiple reasons, more than 3	29.9	4.6
Non-definable	1	0.2
Total	100	100

''management'', ''project culture'', ''multiple reasons'', ''organization'', ''Personnel skill and talent'', ''lack of resources'' and ''attitudes''. These problems and their causes all affect one another. Combinations of over 1% account for 20% of the total table [13,18] and they account for roughly 71% of the percentage observations from the materials (Pareto principle).

6.1. Responses

As we detect early warnings of problems or start to suspect a project problem might be there to threaten the project, it is important that we do not stay content with this knowledge or suspicion, but actively start carrying out measures to lessen the threat. According to the study, the situations vary so greatly that no simple, general model for deciding what measures to undertake is easy to prepare on the basis of such a limited investigation. However, this knowledge can be supplemented by knowledge derived from the literature. Several books on project management have been written to find out what kinds of responses should be applied in different situations relating to project problems. Table 6 presents responses that came up in the study and also those that came up in the literature [13,18]. Among those that came up in the study were: ''more effective monitoring'', ''communication with management'' and in some cases, ''adapting to the situation''. Also evident were various people's ways of reacting, depending on their respective experience and methods of management: either a quick reaction or cautiousness. As for the effects of the procedures, it should be borne in mind that the so-called Hartney Effect has been observed quite unambiguously in project work. When the client expresses 'interest' in the activities of the other party, this has an improving influence on the quality of activity.

Table 4
Early warnings, main groups–project problem, main groups [13,18]

Early warnings, main group	Project problems, main group (%)			
	Schedule problems	Delivery problems	Planning problems	Management style problems
Personnel, project group	2.31	3.09	4.02	6.38
Project parties	1.84	1.72	2.43	2.76
Documents	2.58	2.08	1.03	1.32
Working within the project	2.29	0.91	3.40	1.46
Project planning	0.94	3.10	1.55	0.76
Communication	0.44	1.14	0.58	2.23
Differences and deficiencies in project culture	0.17	1.19	1.29	2.64
Project control and reporting	2.76	1.36	0.81	0.54
Project manager, management	0.10	0.77	1.03	0.91

Table 5
Project problems–causes of project problems [13,18]

Project problems, main group	Causes of problems (%)						
	Management	Project culture differences	Many reasons	Organization	Personnel skills	Resource shortage	Attitude
Time, Schedule problems	1.68	3.25	4.75	1.06	1.09	1.43	0.88
Performance, Delivery problems	1.88	4.15	2.02	0.96	1.97	1.63	0.93
Problems in management, total	3.23	4.61	3.25	1.85	1.10	1.53	2.20
Planning, tech	2.76	6.59	1.35	2.35	0.57	2.67	1.29

Table 6
Responses to consider on the basis of the signals. [6,7,13,18–22, 31]

Problems	Response recommendation
1. Project environment	Problem external to the project management
	Stakesholder Management [31]
2. Objective/Scope	Preparing the project plan
Technical Performance	Problem analysis methods
Delivery problem	Prequalification of suppliers
	Exerting pressure as problem surface
	Delivery control (inspections)
	Schedule correction (adaptation)
	Hiring expertise from outside
	Preparing exact contracts
Cost overruns	Problem analysis methods
	Budget adaptation
	Strictly disciplined budgeting
Schedules	Problem analysis methods
	Schedule correction (adaptation)
	Increasing resources
	Negotiations
	Exerting pressure as problem surface
3. Client	Problem external to the project management
	Stakesholder Management [31]
	Client perspective [30]
	Being cautious
4. Project manager	Problem external to the project
5. Management and Leadership	The literature; the chapter on Mgn. and Ls
Mgn. and Ls. problems	Hiring expertise from outside
	Organization changes
	fake organization, unofficial channels
Differences in project culture	Negotiations
	Adapting to the situation
6. Project group/organization	The literature; Team management
Lack of resources	Acquiring additional resources
	Adapting schedules
7. Personnel/motivation	The literature; the chapters on leadership
8. Project Planning	The literature; making a project plan
	Making plans by ourselves
	No accepting of incomplete plans
9. Monitoring/Control	The literature; project control
10. Communication	The literature; communication

6.2. Dependency net

The material can be used for drawing up a ''dependency'' net (Fig. 3) between early warnings, causes of problems, problems and responses. It has early warnings on the left (rectangles), followed by the causes of problems (rectangles in bold type), then by the problems (rectangles with rounded corners) and the responses that came up in the study (rectangles with rounded corners in bold type). The figure includes the ''dependencies'' that occurred in at least 2% of the observation material. However, according to the qualitative research method, all observations are significant.

As a consequence, the complete observation material must be used (it can be found in the original research paper [13,18]). This becomes important when one is to examine the material on a basic classification level of early warnings and find out the problems the signals refer to and the prevalent reasons for them. At this stage, it becomes evident that the main classification and the picture derived using it may provide information that is ''misleading'', too generalising and coarse. Fig. 4 [13,18] depicts how large and diverse the net of early warnings related project problems and the causes of the problems can be in some cases.

This picture has the early warnings on the left, with the problems (scheduling problems) in the middle in halftone, and the causes of problems on the right. The arrows depict the dependencies. The problems and their causes may influence each other. The early warnings refer to problems only. Through the halftone field, there are broken lines to point out the early warning from which the cause of each problem was found in the study.

6.3. Methods

Methods is the group of procedures (responses) for obtaining more information on the situation. Thus, they are part of the model presented farther on, when the information available on the possibly impending problem is very inexact but it is estimated that there is enough time for countermeasures. Several other methods for finding early warnings also came up in the study conducted at

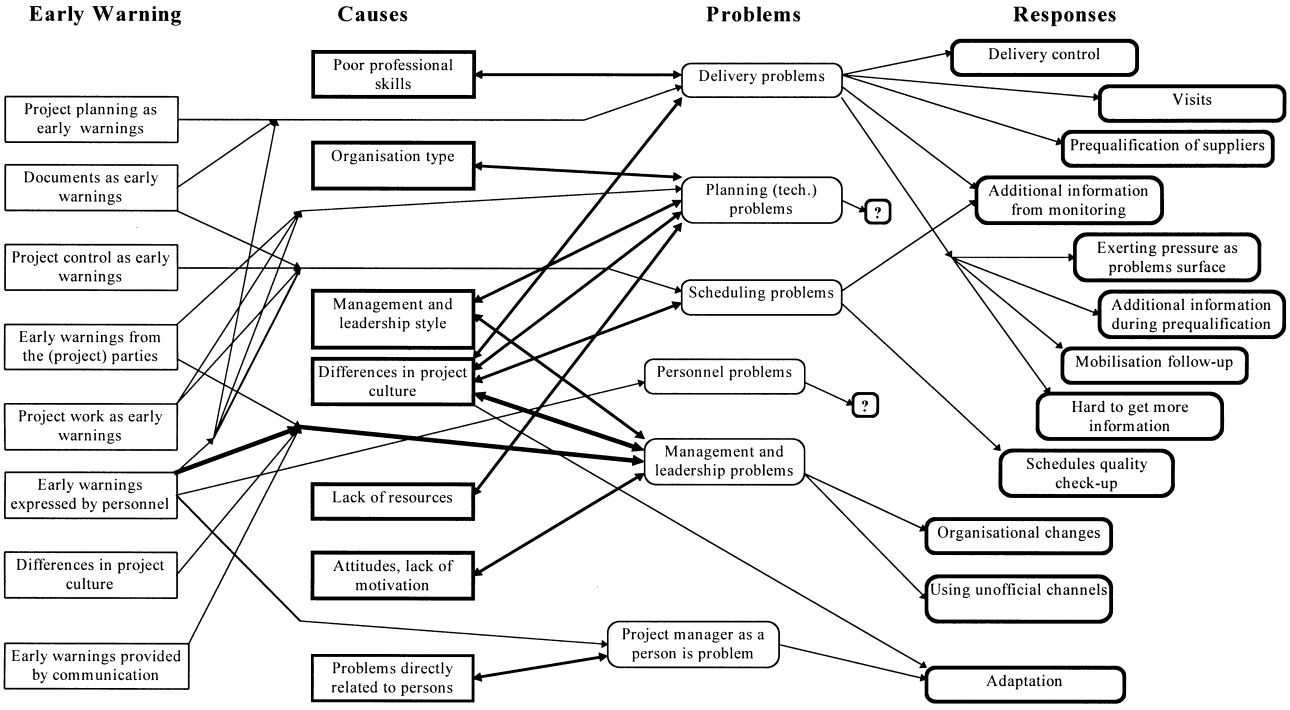

Fig. 3. A net of early warnings–project problems–causes of problems–responses [13,18].

HUT. They can be used to obtain more information on impending problems. Table 7 presents a summary of the methods identified.

The experience of the observers and their keenness to observe and identify preliminary signals can be considered the most important approach or method. A number of methods typical to project work also came up during research, e.g. "monitoring mobilisation at the site", "asking provocative questions in tender negotiations". According to the study documents, written material is one of the most common sources for early warnings. Thus, analysing them is a very fruitful method for gaining more information. Such analysis would include for example reading between the lines of contracts, observing the reports tone and regularity of publication, careful searching for loopholes in contracts etc. However, one should not forget the conventional methods used in project work for obtaining information, such as reporting in general, monitoring and control, setting goals and comparing them to results, and regularly held project meetings. Still, these methods have the weakness of being based on "historical" information.

6.4. Chains

An interesting observation made from the literature [10,20,21], some research studies [23,24,25] and the material used for this study is that early warnings, project problems and their causes may form rather long, multi-branched chains. It appears that the interpretation of the observed phenomenon may change its character, from early warning up to even becoming a cause for a problem, depending on the point in time and the point of view.

Fig. 5 [13,18] illustrates the formation of chains, cited with some types of responses as the last element (not included in the picture). First, the problem (A) observed at time $T-n$ ("yesterday") has its cause. This problem (A) may be causing possible problem (B). Thus, it is the cause of (B). If this causal relationship is identified "immediately", problem (A) can be interpreted as being also an early warning for possible problem (B). Second, when problem (B) is actualised at time T ("today"), the interpretation of the character of (A) has turned into being the cause of the problem (B). However, it was still an early warning for problem (B) at the time it was observed ($T-n$). third, such a situation can be repeated at T ("today"), when the observations anticipate the situation at time $T + m$ "tomorrow", thus providing an early warning on possible problem (C). Naturally, one could also identify other early warnings for a possible problem. The chain can be very long, almost "endless". Research in risk management also indicates that chains can branch. To make sure the activity would involve not only monitoring of the current situation but to facilitate actual project management, many more things are needed (not included in the picture): countermeasures for the problems, follow-up, analysing, and observation regarding the early warnings.

7. Set theory and early warnings

This study [13,18] examined project problems found in the literature and their causes from various points of view. The problems and their causes were found to be so similar that they were combined in the same table. Fig. 5 examined how the interpretation of the phenomena observed in projects — early warnings, problems and their causes — may vary during the various stages of a project. The material found in literature and in the study would seem to indicate three things. First of all, it is possible during projects to observe and identify

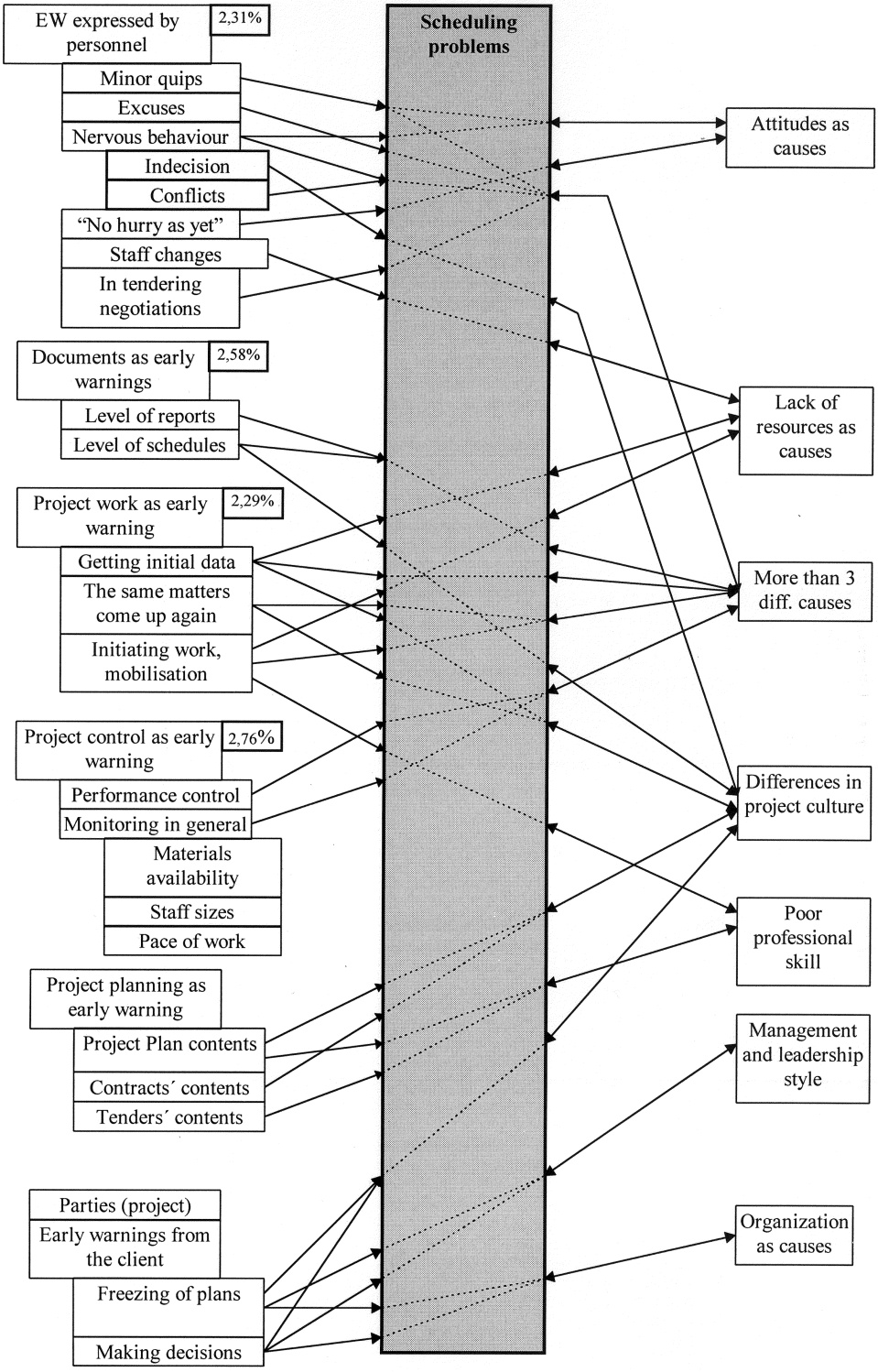

Fig. 4. Dependencies between early warnings relating to scheduling problems and the causes of problems [13,18].

phenomena that can be interpreted "purely" to be warnings on future problems, signals expressing existing problems or actual causes of problems. However, in no circumstances could they be interpreted in more than one way. Second, the research study [13,18] found a significant similarity among project problems observed in project-related literature, their causes and early warnings (symptoms) of project problems. This and the phenomenon of the chains formed (Fig. 5) indicates that an identified phenomenon can be interpreted in various ways, such as a warning, as a problem or as a cause of the problem, depending on the project conditions at the time of observation in the various stages of project activity. Lastly, it is fairly obvious that other factors likely belonging to two groups could also occur. Corrective measures (responses) would appear to be another group completely separate from these. According to set theory, this situation can be expressed in the way it is presented in Fig. 6.

Table 7
Methods [13,18]

Project problems	Method
Scheduling problems	Advence schedule checkup
	More information obtain while monitoring
Cost-related problems	More information obtain while monitoring
Financial problems	Advance research
	Hard to get information
	Hard to get information
	More information in prequalification
Delivery problems	Visiting the supplier
	More information while monitoring
	Monitoring site mobilization

The contents of this common "group of project problems" would seem to have quite a lot in common with the risk groups and risk factors found in risk management

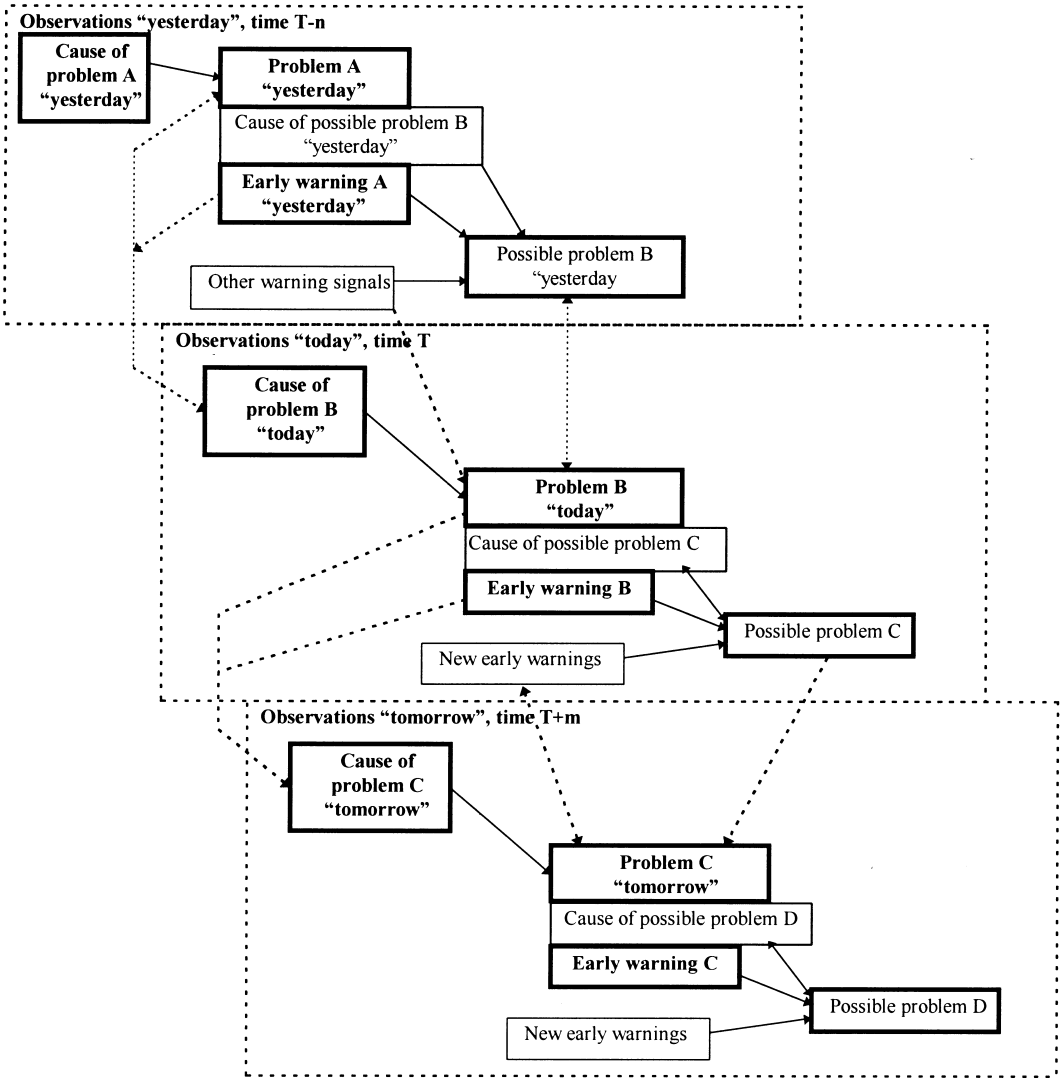

Fig. 5. A chain of problem causes–problems–early warnings–responses [13,18].

studies. When a project problem is perceived as a "possible problem", the phenomena are connected to each other on the basis of the definition of risk.

8. Concepts relating to the phenomenon and the character of risks

According to the definition of risk, any possible problem is a risk. Because early warnings refer to a problem that might emerge in the future, the relation of the early warnings phenomenon to risk management is rather obvious. This is evident in both the literature [10] and in the empirical section of the study [13,18]. Fig. 7 presents the main concepts, their parallel concepts and how they influence each other.

9. Possibilities for utilisation

The observations made regarding the methods and the attitudes of the interviewees serve to indicate the possibility of utilising early warnings as a tool in project management. Some models for utilising weak signals can be found in the literature. Ansoff [11] presents a strategic issue management system (SIMS) model in the area of strategic planning and management. He has later transformed this model into a model for weak signals strategic issue management (WSSIM) [11]. Several other writers have also presented their own SIMS models differing from that of Ansoff's mostly in detail. In his book Åberg [2] (written in Finnish) explains the external and internal scanning that is part of company communications. The model is based on the principles of the IPRA Mexico declaration [25]. Core questions posed by Åberg applicable also to project work are:

> "Is the change observed a symptom of a larger, essential change or is it merely random variation."
>
> " How is it possible to observe weak signals as soon as possible, so that there would be as much time as possible to respond to them" [2, p. 250].

As part of his "managerial breakthrough" management model, Juran [26] states that sensors are required for activity based on "sensing before the fact". In this case, we would be looking at indicators of the early warning type.

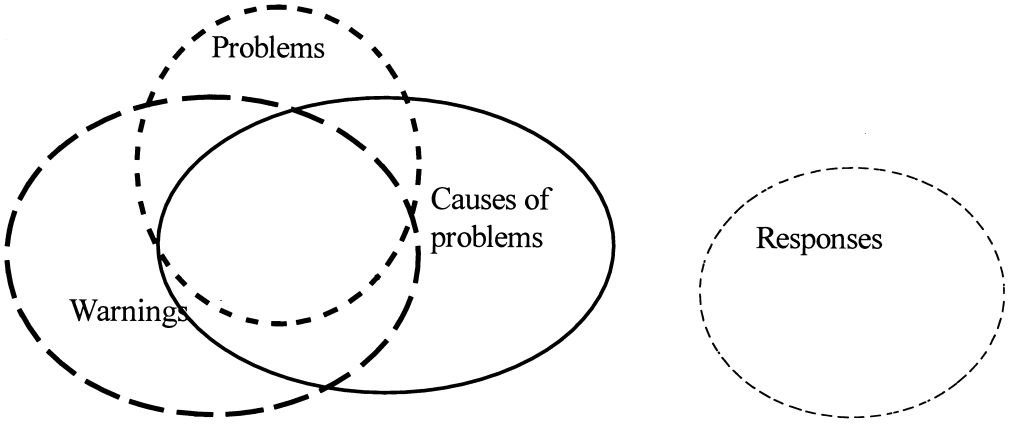

Fig. 6. Groups of warnings, problems and causes [13,18].

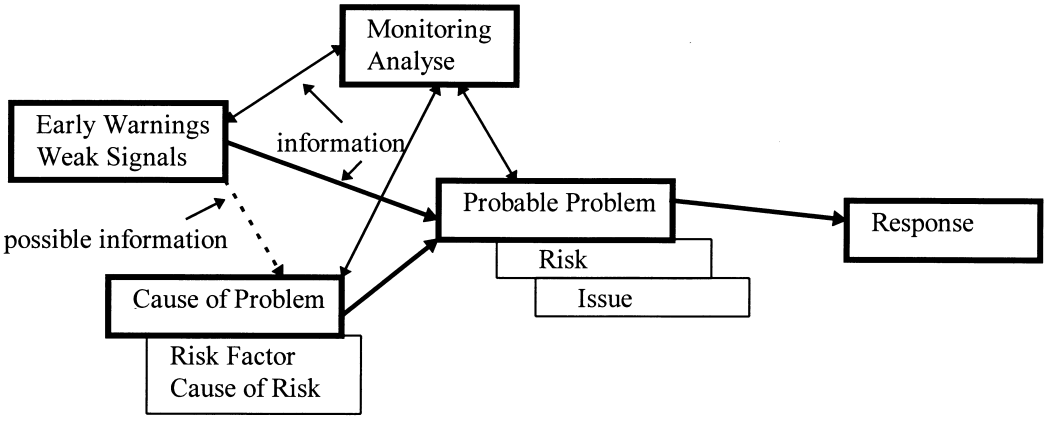

Fig. 7. Concepts relating to the early warnings phenomenon and their relation to risk management [13,18].

None of the models presented in the literature is applicable in project work without modification. One could always try to apply the problem analysis model developed by Kepner–Tregoe Inc. [27]; however, this one is thorough but works slowly. The basic principles of the models presented are applicable to project work, but the procedures used must be very flexible, quick and simple.

10. A model for the utilisation of the theory

Fig. 8 presents the model for utilising early warnings, developed during the research work reported herein. In addition to Ansoff's WSIM model, it was influenced by ideas presented by Åberg [2] and the structural model of the functional unit of social activity by Heiskala [28] and conversations about the phenomenon with a number of people.

In a warnings based situation depicted by Fig. 8, the first (1) phase is the identification of a warning (signal), almost always by a person, from the flow of project events. In the second phase (2), the observer accepts the finding and starts to react, i.e. considers it an "early warning" or considers it useless and rejects it. Now, we can use the typical groups of early warning types established by the research, including their descriptions and examples of the kinds of warnings there can be (Table 1).

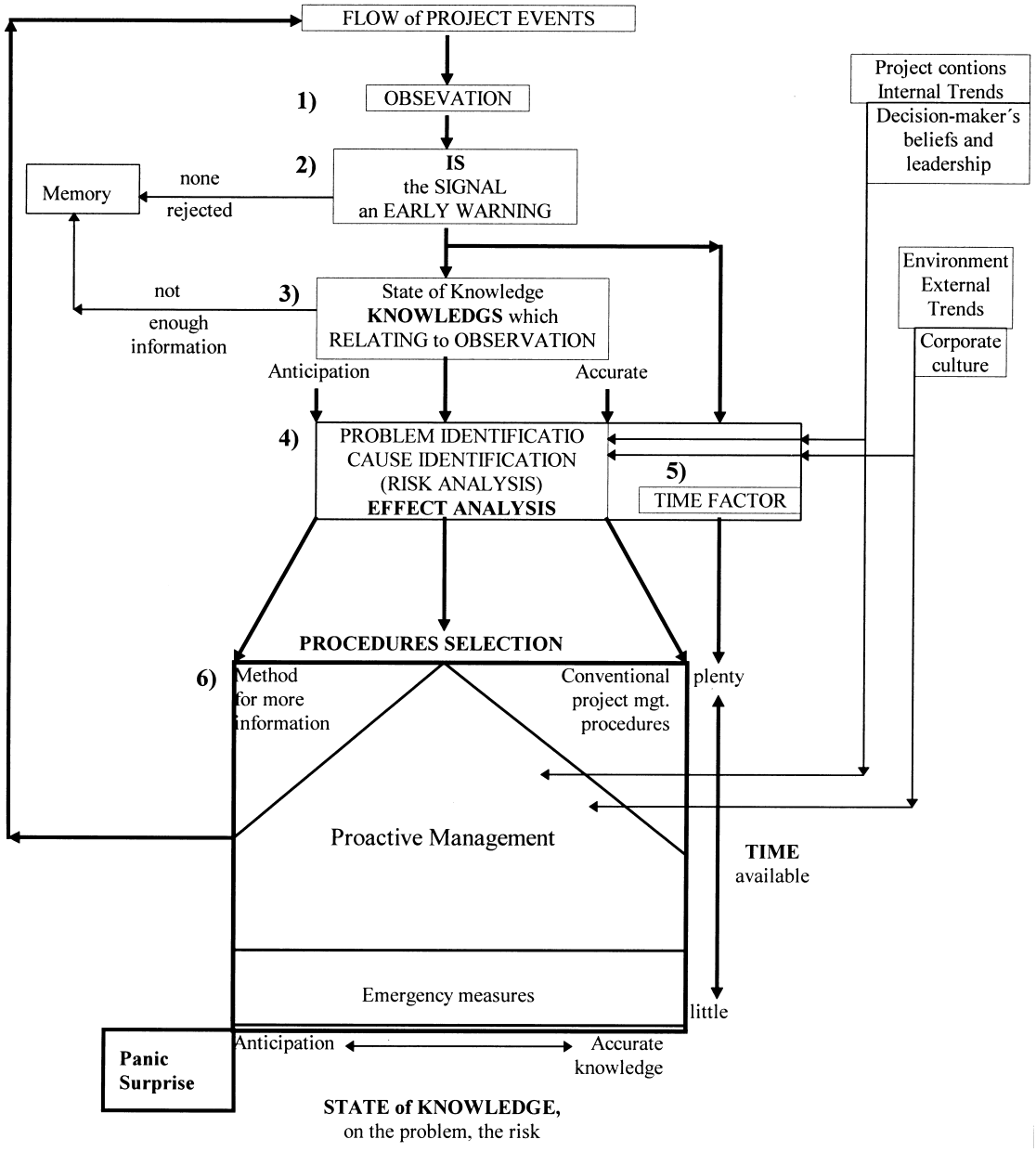

Fig. 8. A model for utilising early warnings [13,18].

In the third (3) phase, the observer will try to determine the state of knowledge gained from the early warning, and the meaning of the information to the project. The scale of evaluation need not be absolute or generally applicable as long as it can somehow be specified in the situation. If the information obtained appears unnecessary or too scarce, it should still be recorded, because further information on the matter could come up later. In the fourth phase (4), the emerged problem (risk) and its possible causes (risk factors, the sources of risk) must be identified. In addition to all the information (typology) provided by the warning, this evaluation is also influenced at least by project conditions (internal trends), external trends and the "beliefs" of the interpreter regarding the signal. If not earlier, the possible utilisation of various methods of project risk management (risk analysis, etc.) will come up at this stage. One could also use a database such as the one developed in the course of the study [13,18], a database on the relation of early warnings to project problems (risks) and the knowledge on the dependencies between project problems and their causes (risk factors). Fig. 3 expresses this in a simplified manner. The time factor (5) is being considered along with the identification of risks. An answer to the following question should be sought: how much time is needed for countermeasures (responses) required by the problem (the risk)? In other words, what is the urgency of the situation? This is also strongly influenced by the project situation, project conditions (internal trends) and external trends, and the interpreter of the signals.

One of the problems in project work is that the person who identifies/interprets the early warnings is often not the same as the one who is making the decisions. Especially regarding the client, the final decision-maker is often rather inexperienced in the special matters relating to project work. The greatest difficulty in phases (4) and (5) likely is convincing the decision-maker that there is a problem, that it has an effect on the project and that corrective measures (responses) are necessary. Here, one could talk of a believability problem. It came up in the interviews and is strongly present in research concerning military intelligence, international security and risks [3,4]. The observer must convince the decision-maker that the impending problem has personal significance to the decision-maker. This can hardly be achieved with the help of any particular method; sensitivity toward early warnings (weak signals) must be instead cultivated. One must trust the information derived from the signals and make others believe in it as well.

Finally (6), one should try to decide which responses to focus on in any given situation. This is depicted by the lower part of the matrix in Fig. 8, which includes these aids for decision-making: (a) the information available on the problem (the risk) and its graded effect on the project, and (b) the urgency of countermeasures (the amount of time available). At least the following factors also directly influence the selection of responses: (c) project conditions (internal trends), (d) the environment (external trends), (e) the decision-maker's position within the project and/or his/her "beliefs", (f) corporate culture, and (g) the effects the response is hoped and believed to have on the project.

Extreme situations in the decision matrix are as follows:

(a) If there is plenty of time, but the quality of the information available is not so good (a feeling), one may settle for choosing "methods" for gaining more information. (Table 7) This is the upper left part of the matrix.
(b) When there is plenty of time and the information on the problem (the risk) is exact, conventional project management methods may be used. This is the upper right part of the matrix.
(c) If there is little time and the exactness of the information is anything between a feeling and exact information, various "emergency responses" may have to be used. This is the lower part of the matrix.
(d) When "outside" of the matrix, if there is no advance information on the risk and thus it materialises by surprise, some kind of a "panic situation" will probably emerge as the risk actualises.
(e) When in the "middle" of the matrix, one could think of applying proactive management. This study cannot be used to develop this idea any further.

It is also significant to note that many of the problems (risks) may be outside the authority of the person making the decisions. This becomes evident in the material when analysed.

No advance information should be entirely abandoned. Even insignificant information should be recorded somewhere for comparison with other older data and later with some new data. This is difficult to achieve manually, but technically possible using database programs.

11. Leadership

The application of the phenomenon of early warnings seemingly makes it possible to expand to greater portion of project management, especially in the domain of (human) leadership. The type groups of early warnings are related to the human factor in 47.5% of the observations in the basic material and in 49.6% of the case material. Of all the examples of early warnings that came up in the literature review, those that relate to humans account for roughly 66%. In all observations regarding early warnings, human activity has been kept in the background to say the least. For instance, documents are always drawn up by humans. Humans are the

direct source of warnings in roughly 62% of the observations. In the empirical material, human-related problems account for 35.8% of the observation cells in the basic material and for 28.4% in the case material. As for the causes of problems, the observation is that the greater part of the causes are directly due to humans. Human action is the basis of all of the cause groups.

All of the view points presented here show how strongly the phenomenon of early warnings is connected to people and human behaviour. As a result, the signals could help in leadership issues. However, in doing this we would be going into the area of leadership and behavioural sciences, which were not considered by this study.

12. The effect of the study on theories

This study shows that it appears to be possible to observe, in project-related activity, early warnings that fulfil the criteria set by Ansoff's theory for the existence of such signals. The study appears to show that the different warnings observable in the project activity have a varying informative content. This is consistent with Ansoff's theory. No unambiguous scale exists in this study for measuring this informative content. The scale remains very imprecise. The same applies to the time factor with early warnings. The time factor appears to exist, but it cannot be measured from the material researched. The study enlarges the area of application for Ansoff's theory into project-related activity.

This investigation finds that many project professionals are already familiar with the existence and they make use of these indicators in some unstructured and often unconscious way. A similar observation can also be made of literature on project management. The study hopefully adds an element to project management theories that was previously known but little researched. This element is project control using imprecise information. We have attempted to explain the characteristics of this phenomenon in the study. The intent is to increase knowledge of the theories of project management.

This analysis states that the project problems to be forecast, using early warnings, are risks (the definition of risk). In this sense, the early warnings phenomenon can be said to be primarily a project risk management theory. Theories regarding project risk management acknowledge the existence of early warnings only as a reference (risk symptoms) [29], although Niwa [10] includes the idea of risk alarm in project risk management requirements. Despite the limitations of the study, it can be said that it confirms the risk symptoms element of the project risk management theories. This element may be used to increase the predictability of the actualisation of risks, however, further research is required.

13. Conclusions

There is less and less time to react to emerging challenges, problems and opportunities in projects in the changing, turbulent environment of companies and hence of projects as well. Companies cannot afford to have projects fail in any way, particularly with reference to time, finances or technology. The conventional methods of project management are based mainly on the "history" of project events and hence cannot really anticipate emerging or unforeseeable problems.

In the flow of project events, countless signals (early warnings) have been observed to occur, the precision and imprecision of the content of the information they provide varies greatly. At their most imprecise, they are mere "gut feelings", while at their most precise they can be given a numerical value and what can be done about the situation is known precisely. The precision of the signals improves in time but the time available for countermeasures decreases, because the problem's moment of manifestation is not likely to be moved farther.

Project managers may observe such signals and interpret them according to their experience and observation conditions, provided they have become sensitive to observe such signals. The management will gain information on emerging problems (opportunities). Management will be able to take appropriate action as the project situation, project environment and the time available allow. The sooner the better. In the least dangerous case, it would be possible use some method to collect more information on an emerging problem and at its worst, a problem will come as a complete surprise and panic-driven activity ensues. The biggest challenge is to get the actual decision-makers to believe in the possibility of problems and the necessity of countermeasures, because these people generally have little experience with the clients in projects.

In part, the model presented in this article may help resolve this problem.

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