TRANSFERABILITY OF THE SYNOPTICAL AND INCREMENTAL PLANNING APPROACH TO TECHNOLOGY PLANNING: A LITERATURE REVIEW

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ABSTRACT

Planning is regarded as a common and standard practice both in the industry and science. There is a wide range of different planning areas in companies, such as sales planning, personnel planning, procurement planning, marketing planning, technology planning etc. The significance of each area varies depending for instance on the industry sector, organizational structure, economic situation. For technology-oriented companies technology planning is of essential importance, as it defines which technologies need to be provided for which period in order to produce certain products. In an increasingly complex environment technology planning supports companies to master the overall complexity as it creates transparency over technological strategies and objectives. Further, technology planning gives an overview of company-relevant technologies and the corresponding activities such as research and development activities, e.g. via technology-roadmaps. Often the question arises how companies can conduct their technology planning more effectively and efficiently as well as in accordance to their contextual framework. Technology managers demand for more guidance respective how to set up their technology planning especially in terms of changed markets and technological environments, e.g. in times of leaps in technology. Examples for disruptive technologies are analog cameras relative to digital cameras, cellular phones to wired phones, MP3-Player to Portable CD-Player. Against the background of growing competitive pressure, more complex technology chains, increasing derivatization, reduced product and technology life cycles, technology planning in contrast to general planning strongly focuses on factors influencing its technological competitiveness, such as technology development of e.g. competitors. A lot of work has been accomplished in the field of planning and planning approaches in general. But only very few of these works have included technological aspects in terms of context and design possibilities. This aspect, i.e. different objects of observation depicts the major difference between the disciplines of general planning and the more specific technology planning. Based on the fact, that little systematic knowledge is available respective a technology planning approach, its design dimensions and contextual factors, a well-established and often applied approach of general planning will be investigated. The aim of this paper is to give a judgment whether the approach, the synoptical and incremental approach suit for being transferred to the discipline of technology planning. A literature review gives a better understanding of the approach's characteristics. Further research paths for technology planning will be recommended in order to fill the gap both in science and practice.

Keywords: synoptical and incremental planning approaches, technology planning approach, transferability, literature review.

INTRODUCTION

Organizations of each kind are facing an increasingly complex and dynamic environment, both internal and external. In order to master the challenges and to anticipate future actions organizations use planning as a management instrument [Albach, 1978; Hammer, 1992; Hahn, 1996]. Based on its functionalities and benefits, planning has become firmly established during the last decades. Numerous works have been accomplished in order to provide users with more methods and tools for improving their planning process [Hahn, 1996; Mintzberg, 1995; Ansoff, 1990]. These works deal with the development of reference planning processes, the investigation of factors influencing planning, different planning approaches etc. [Mintzberg, 1995]. The latter describes a company's basic setting or understanding regarding its planning process and contents.

It is often observed that companies do not plan their technologies systematically enough and not according to their contextual framework. In a first step, a technology planning approach needs to be set up in order to create transparency over the time horizon, required personnel, tools, methods, planning frequency, planning organization, planning input etc. The distinctiveness of a technology planning approach lies in its defined object of consideration. The approach needs to be designed in a way that it can realize the goals which are defined in the technology strategy as best as possible, e.g. regarding technology timing, technology performance, technology source, technology exploitation [Schuh, 2013]. In a second step organizations can implement their technical planning process based on the defined approach. This paper's objective is to investigate whether the existing synoptical and incremental planning approaches are suitable for transfer regarding technology planning and in which areas future research is required.

This paper is structured as follows. In the section "literature review" the synoptical and incremental planning approaches will be reviewed. Also the important factors affecting planning and their interdependencies will be illustrated. In a next section "Gaps in the literature and future research potential" the research gap and next steps will be discussed in order to enhance a better understanding and applicability for technology planning approaches. In a subsequent section the results will be depicted showing concrete fields of action. Final comments will conclude the paper.

LITERATURE REVIEW

Authors such as Mintzberg, Rueth, Zahn, Szyperski, Rau, Ansoff, Al-Laham, Wall and many others have already analyzed planning's contextual factors and design parameters. Figure 1 illustrates an extract of the planning literature and the different foci these authors have set within the framework of their investigations. Further, Figure 1 depicts possible contextual factors and design parameters which have been already analyzed by authors. For instance, Mintzberg has analyzed the contextual aspects "environment", "strategy" and puts more emphasis on the "internal context" (firm's internal environment) as well as the contextual constellation itself. Respective the design dimensions Mintzberg stressed the dimensions "tasks", "personnel" and "formalization". Secondarily, he analyzed the aspects "philosophy", "planning and control system", "organization", "process", "planning input" and "planning technologies" [Mintzberg, 1995]. Ansoff for example has put more emphasis on the contextual aspect "environment". Within the design dimensions he strongly focused on "planning input" [Ansoff, 1990].

In the next sub-sections an introduction will be given on the synoptical and incremental planning approaches as well as some hybrid options and on possible design dimensions as well as contextual aspects.

Planning Approaches

Planning approaches describe the overall basic setting, i.e. guidelines for conducting technology planning. It is widely recognized that planning approaches can be divided into a synoptical [Ansoff, 1990; Albach, 1969] and incremental approach [Learned, 1965; Katz, 1970]. These two approaches depict the extreme ends of the entire range of the approach's characteristics. In practice, most firm's do not apply a pure form of approach but tend to implement a more mixed approach, such as the synoptical-analytical approach, incremental-entrepreneurial etc. [Paine, Anderson, 1977; Wohlgemut, Hess, 2000].

The synoptical planning aims at mastering the complexity of a planning problem in a holistic, comprehensive way without dividing it into sub-problems. This planning approach tries to capture and process as many relevant information as possible [Picot, Lange, 1979]. In a first step one or many objectives are being defined. In a later planning process phase these objectives are being used in order to assess different strategies and to select strategies by the management (top-down). During this process the corporate strategy will be reviewed periodically, revised and forwarded to a lower hierarchy level [Wohlgemut, Hess, 2000].

	Zahn	Szyperski	Rüth	Ansoff	Mintzberg	Hahn	Al-Laham
Context aspects surroundings strategy	1	1	2	2	1	1	0
internal context constellation	1 0	2	2 2 2	1 2	2 2	2	1 0
Functional design dimensions philosophy tasks plans & control	2 2 2	1 2 2	1 1 2	1 1 1	1 2 1	1 2 2	0 2 2
Institutional design dimensions structure process personnel	1 2 1	2 2 2	2 2 1	1	1 1 1 1	2 2 2	2 2 0
Instrumental design dimensions planning input technology formalization	1 1 1	0 2 2	2 2 1	2 1 0	1 1 2	2 2 1	2 2 2

Legend:0 = not processed, 1 = partly processed, 2 = processedFigure 1: Overview of the scholarly contribution to the discipline of planning (extract)

The incremental planning approach manages a planning problem via splitting it into one or many sub-problems. The solution is getting developed progressively and not necessarily in a logical sequence. Thus, the incremental approach does not explicate goals but identifies urgent sub-problems of a superordinated complex problem and tries to solve them. The author Lindblom states, that actions are possible and manageable without common goals and without the existence of a coordination mechanism [Lindblom, 1959].

The difference between the synoptical and incremental approach can be described with the help of the dimensions "goals" and "data" (cf. figure 2), which define the scope of solution of a planning problem [Wheelwright, 1970]. The business objectives enclose the scope of

known solutions based on the criterion "acceptance". The data of the environment and business resources define the degree of "feasibility". The synoptical approach primarily aims at fulfilling the desired state, the feasibility aspect is secondary. Whereas the incremental approach first defines what is feasible and against this background the actions are concretized based on the criterion "acceptance" [Picot, Lange, 1979].



Figure 2: Two dimensions of the synoptical and incremental approach [Wheelwright, 1970]

The incremental-entrepreneurial as well as synoptical-analytical approaches are hybrids of the two previously described more extreme approaches. The incremental-entrepreneurial approach's process is a less adaptive but more integrated than the incremental approach. The synoptical-analytical can be described as more flexible in its structure and process than the pure synoptical approach, but is still more limited in its flexibility than the incremental or logic-incremental approach [Paine, Anderson, 1977].

Mintzberg, Ahlstrand and Lampel have examined and consolidated existing works regarding the discipline of strategic management. These authors have identified ten "Schools of Thoughts", which can be divided into prescriptive and descriptive approaches [Mintzberg, 1995]. The prescriptive approach propagates one (single) correct strategy. Whereas, the descriptive approach aims at describing, in which manner strategies develop in practices. Its aim is not to dictate in which manner "correct" strategies need to be developed.

One of the prescriptive approaches is the "planning school". Here, strategy is not the result of a great design or lucky positioning, but the result of an analytical planning process. Based on clearly defined and quantifiable goals and environmental analyses, exact resource and time schedules can be developed. These schedules or plans can be consolidated into an overall masterplan. This school of planning follows a "one-best-way-philosophy" and assumes a predictable environment. Further, this planning approach supposes that the environmental complexity can be managed via intensive planning, control processes and gathering of mass data with complex tools [Mintzberg, 1995].

The planning school of Mintzberg portrays similar assumptions and procedure as the synoptical approach. So it can be noted, that the school of planning can be assigned to the "synoptical approach".

Planning approach and its design dimensions

This section describes design dimensions of general planning and design dimensions of the synoptical and incremental planning approaches.

In order to manage the complex contextual framework of planning, i.e. planning approaches, various dimensions can be developed, with which firms can design their planning approach. Design parameters can be clustered into functional, organizational and instrumental aspects [Horvath, 1998]. Figure 2 illustrates this classification.

Functional design dimensions contain the planning philosophy, planning and control system as well as planning tasks. Planning philosophy can also be understood as planning approach and describes a company's basic setting or attitude regarding its planning. It is assumed that this design dimension is of essential relevance since it affects other dimensions [Szyperski, Müller Böling, 1980]. Unfortunately, these authors never conducted an in-depth investigation on this central aspect. This paper's authors are currently conducting detailed studies regarding this research gap.

The synoptical and incremental planning approaches can be characterized based on seven dimensions (cf. figure 3).

The synoptical planning approach is characterized by a more anticipating and goal oriented decision-making and planning behavior, a more analytical, comprehensive evaluation process of many alternatives. With a long-term planning horizon, more formalized planning process it aims at achieve its concrete goals via integrated and continuous process steps.

On the contrary the incremental approach acts more reactively and primarily deals with urgent, actual problems and does not plan in alternatives. The incremental planning approach tries to achieve its unspecified, short-term goals based on separated process steps and adapts its planning according to the specific actual situation.

	Synoptical	Incremental		
Decision-making and planning behavior	More anticipating & goal oriented	More reactive, focussing urgent problems		
Evaluation process of alternatives	More analytical, comprehensive	More intuitive, political process		
Planning horizon	More long-term, comprehensive	Short-term, limited to actual problems		
Planning flexibility	Limited	Adaptive		
Planning continuity	Integrated, continuous steps	Serial, unconnected steps		
Goal orientation	Specified	Unspecified		
Amount of alternatives	Many	One		

Figure 3: Characterization of the synoptical and incremental approach [Mintzberg, 1995]

These planning approach design dimensions depict an excerpt of possible parameters. It is to be analyzed which dimensions are relevant for the technology planning approach and which

additional dimensions need to be identified in order to create a holistic view of the technology planning approach.

Planning and a company's environment, strategy, its structure and success

Various dimensions affect a firm's planning. These dimensions are also called influencing or contextual factors. They describe a company's internal and external situation, which can hardly be changed. Different contexts induce different solutions for the design problem [Buchner, 2002]. Figure 4 depicts the interdependencies between a firm's environment, strategy and its organizational structure. Here, the organizational structure contains the planning system. The environment strongly influences the organizational structure (arrow 1) [Lawrence, Lorsch, 1967; Burns, Stalker, 1961]. Various characteristics of the organizational structure also affect the management's perception of its environment's development, so that both influencing factors are strongly interdependent (arrow 2) [Anderson, Paine, 1975; Downey, Hellriegel, Slocum, 1977]. It is being assumed that a fit between environmental and organizational structure benefits the value creation (arrow 3). On the other side, a positive success affects structural changes via the management (arrow 4) [Child, 1972].

"Structure follows strategy" is a widespread quotation by Chandler [Chandler, 1962], which implies that strategy affects the organizational structure (arrow 5). Then again, Bower [Bower, 1970] points out that the organizational structure has influence on the strategy formulation in form of a information filter ("strategy follows structure") (arrow 6). Rumelt has proven that a strategic and structural fit results in success (arrow 3).

Since companies define their environmental domain via strategic decisions, it can be stated that strategy affects the environment (arrow 7). Technological, legal and competition-related environmental variables limit the strategic freedom of action (arrow 8) [Hofer, 1975]. It is being assumed that a fit between the environment and strategy is a main success factor (arrow 9) [Porter, 1983].

Some enhanced scientific works have demonstrated the success itself is a prerequisite for strategic changes (arrow 10) and that success changes the industry structure (arrow 11). Bourgeois and Astley have illustrated the importance of internal and external fit for an organizations success [Bourgois, Astley, 1979]. Strategy connects structure with its environment. In concrete, the internal coordination between strategy and structure - both in procedural and contentual aspects – are essential requirements for the external coordination of organizations with its environment for being successful [Al-Laham, 1997].

In summary it can be noted, that an organization's planning system, which is embedded in the organizational structure is strongly related to other both internal and external factors, i.e. strategy, success and environment.



Figure 4: Interdependencies between environment, strategy and organizational structure in a Neo-Contingency-Modell [Bourgois, Astley, 1979]

Buchner has investigated the configuration of planning systems in a complex and dynamic environment based on different company types ("machine bureaucracy", "divisionalized company", "small niche supplier", "innovative adhocracy"). He identified possible design dimensions and analyzed the internal and external factors which influence the design dimensions (e.g. planning and control system, planning activities, organizational structure, planning personnel). As a result practitioners are given a general orientation under which circumstances which planning type suits them most and how they should design their planning system [Buchner, 2002].

In summary, a lot of research has been conducted in the field of planning in general and its different approaches. Also scholars have investigated the factors influencing planning systems as well as the possible dimensions, with which they can design and align their planning. Technology planning, thus, is strongly related to planning in general, even if the object of observation is a different one. Technology planning strongly focuses on technologies and how they shall be managed. But until now, there is little knowledge regarding the characteristics of a technology planning approach, its different design dimensions and contextual factors. Since, general planning and technology planning are similar to each other respective their functions and goals, the more studied and established general planning approach can be an adequate basis for developing a technology planning approach.

GAPS IN LITERATURE AND FUTURE RESEARCH POTENTIAL

The aim of this section is to illustrate the emergent gap in literature and to call attention to some aspects that would benefit from future scholarly work.

Planning and design dimensions

As described in the previous section many authors have accomplished work in the discipline of planning and have worked out parameters with which companies can design their planning, i.e. planning approach. As of this writing, little scientific work has been published illustrating the relevant design dimensions of technology planning and its approach. Thus, it is of major relevance to identify and characterize these possible design dimensions systematically and holistically based on works done in the field of corporate planning etc. Therefore, a morphological box represents an adequate visualization tool.

With a comprehensive analysis practitioners will be given an overview of possible design options and its characteristics for aligning their technology planning approach to their specific context. Possible design dimensions are "planning horizon", "planning task", "planning input", "formalization" etc. These dimensions are also characteristics of the synoptical and incremental approaches.

Planning and contextual framework

In the past decades many work have been done in order to create a better understanding regarding factors influencing planning, such as strategy, organizational structure, environment, firm's success etc. Taking into consideration that most of the work done in this field can be dated back to the 1980's and 1990's more contemporary studies are needed considering changed market dynamics, organizational structures, technologies etc. Nearly none of these works have examined the technological aspects influencing a firm's planning approach or process. And exactly this gap must be filled now by scholars. Answers are needed regarding which aspects influence technology planning to what degree and whether different influencing factors together have a mutually supportive influence on certain design dimensions. Or do certain influencing factors contradict each other so that this circumstance leads to a reverse adjustment of a firm's strategy? For instance, if a company targets a shortterm strategic goal of "cost leadership" with a technology with a "low level of maturity" (technology), it can be stated, that this goal is difficult to agree on, under normal circumstances. Since, the technology has not been fully tested and economies of scale via mass production are not realistic. In this case, the analysis of contextual factors can make a statement about the internal logic of these factors and show whether the combination of certain factors is contradictory or logic. In summary, more knowledge is required regarding factors influencing technology planning and which implications certain factors have for certain design dimensions.

Further, scientific works lack an integrated understanding of different overall planning approaches (e.g. synoptical, incremental) and their contextual factors. Picot, Lange and other authors mainly focus on the planning approach itself [Picot, Lange, 1979; Child, 1972]. Others such as Poensgen, Hort separately investigates factors influencing planning [Poensgen, Hort, 1981; Rau, 1985]. There are only few contemporary authors who have integrated both aspects into their investigations, such as Buchner or Reimer [Buchner, 2002; Reimer, 2013].

Until now, there is little work which has elaborated various technology planning approaches and the factors influencing it such as technology, strategy, organizational structure etc. The aspect of technology influencing a company's planning system has been neglected and more research is required in order to give practitioners more guidance regarding the design of their planning approach.

Future research potential for developing a technology planning approach

Some future research fields are presented below in Figure 5. First, work must be done regarding a systematic and comprehensive derivation of design dimensions of the technology planning approach. Then, a more in-depth analysis is required regarding the factors influencing technology planning. Here, more emphasis is needed with respect to technological aspects. Then the relationship between design dimensions and influencing factors need to be investigated in order to define certain e.g. types of technology planning approaches.

Additionally, the existing planning literature can be analyzed and further developed in detail. A desired objective is the identification and characterization of different types of technology planning approaches based on existing works and with an integrated consideration of technological aspects. In order to highlight the benefit of technology planning approaches, its added value for firms need to be investigated, for instance in terms of an indicator system.

Fields of action:

- 1. Identification of design dimensions and characteristics for aligning technology planning approach to firm's contextual framework
- 2. Identification of relevant factors influencing technology planning (e.g. strategy, technology, organizational structure, environment)
- 3. Analyzing interdependencies between influencing factors and design dimensions/ characteristics
- 4. Derivation of different technology planning approaches for different contexts

Figure 5: Future research potential

RESULTS AND CONCLUSIONS

The previous literature review and gap analysis have illustrated the current status of research in the field of planning, planning approaches and technology planning. Additionally, this paper has highlighted the emergent need for more research in the field of technology planning. The concrete research tasks have been described in the section before as well as in Figure 6. This section deals with a conclusion whether and to what degree existing work can be used for developing a technology planning approach.

Technology planning can be understood as a sub-process of corporate planning, the existing synoptical, incremental and hybrid approaches are a valuable base for developing a technology planning approach. The technology planning approach too, must provide answers regarding the decision-making and planning behavior, amount of planning alternatives, assessment process of alternatives, planning horizon, planning flexibility, planning continuity and level of goal orientation (cf. figure 4).

Based on this fundament, both contextual aspects and design dimensions of the technology planning approach must be investigated considering technological influencing factors and design dimensions. The technology planning approach needs to give answers to the same questions, e.g. regarding the length of "technology planning time horizon", the "technology planning flexibility". So, further research is needed in order to complete the range of design dimensions for the technology planning approach. Also, contentual technology planning aspects (e.g. technology strategy, technology roadmap) need to be integrated into the technology planning approach such as to what degree and in which frequency firms should conduct and synchronize their technology strategy and technology roadmap. Also the personnel required for technology planning may vary from that of corporate planning.

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