Environmental Context Significance in Strategic Decision Support Systems

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Abstract. Appraising the environmental context in which an organization deploys its activity is a necessity in order to make appropriate decisions and adapting strategies to a context in constant evolution, especially in a time where this context is increasingly complex, uncertain and disruptive. Decision makers therefore need more than ever better tools that aid them to analyze their environment, providing them the most pertinent information to take the most appropriate decisions. In this paper, we attempt to propose a set of reusable artifacts that would facilitate the development of decision support systems for assessing the organization's environment. In particular, we propose an ontology that defines the different elements that shall be taken into account in order to effectively and efficiently scan an environment. We then provide an overview of some analysis techniques and tools that could be useful to analyze, assess and visualize essential information about these elements. Finally, we present two decision support system prototypes that allow a partial analysis of the environment using appropriate interaction and visualization techniques.

1 Introduction

Assessing or scanning the environment of an organization is a necessity in order to make appropriate decisions and adapting strategies to a context in constant evolution. Therefore, organizations are compelled to scan their environment to understand the external forces of change that may affect their future position so that they can develop effective responses [1]. The importance of obtaining a thorough perception of the environment has been advocated by numerous prominent authors in strategic management [2-5]. They see the co-alignment between the organization and its environment as essential for performance and strategy as the key means to achieve this goal. In this respect, environmental analysis is considered an important preliminary activity of the strategy formulation process.

As explained by Ansoff [6], the steadily increasing interest in the concept of strategy is related to the increase in the variability and complexity of the environment in which these organizations deployed their activity throughout the 20th century and their devastating effect on their ability to attain their objectives. It has been shown that context analysis becomes even more essential for businesses evolving in complex, uncertain, and disruptive environments [7].

Over the years, but especially in the last half century, the business environment of many organizations has undeniably become ever increasingly variable, complex and uncertain. The need for methods and tools for assessing the environment of an organization is therefore as high as ever. Ironically, these same drivers that raise the value of environment scanning also make it more difficult due to the increase of information that must be processed to get an accurate picture of the environment. Due to the huge amount of information that must be collected and processed, decision makers should be assisted by decision support systems providing them the tools to systematically take advantage of the information at their disposal [1].

For this purpose, we first present in this paper an ontology to provide insights on how to structure the collected information. In fact, we indicate the relevant elements to monitor and their relationship. Moreover, this should facilitate the development of an environmental decision support system. In addition, we propose a set of models that could be used to analyze the information collected and therefore improve the understanding about the context of the organization. We provide also a variety of complementary analytic and visualization tools which allow users to analyze markets from different perspective and therefore provide a complete image of the context.

2 Methodology

The work presented in this paper is inspired by the design science research framework proposed by March and Smith [8]. This framework maintains that two types of scientific approaches are legitimate in the information systems (IS) domain: a traditional natural science approach, which relies on theory building and empirical testing, and a design science approach, which aims at creating and evaluating artifacts that serve human purposes. In practice, IS research spans over a broad range of methodologies that often integrate elements of both approaches.

This research framework provides a categorization of viable research efforts in IS by arranging them along two dimensions: research outputs and research activities.

Research outputs or artifacts are constructs, models, methods and instantiations. *Constructs* are the concepts forming the vocabulary of a domain, conceptualizations used to describe and thinking about problems and tasks within the domain. The *model* integrates the constructs and expresses the relations among them. *Methods* are a set of steps or an algorithm used to perform a task based on the underlying constructs and model. Finally, *instantiations* are a realization of an information system built on the constructs, models and methods that demonstrates their feasibility and utility.

Research activities are building, evaluating, theorizing and justifying. The former two are the domain of design science, whereas the latter two are the domain of natural sciences. *Building* refers to the conception and construction of the aforementioned artifacts to solve a particular problem. *Evaluating* refers to the assessment of the proposed artifacts according to suitable metrics. *Theorizing* refers to the construction of theories that explain some aspects of the world in relation to some of the artifacts. Finally, *justifying* refers to proving that theories are truthful through the gathering of scientific evidence that supports or refutes them.

The resulting framework is a four by four matrix that contains sixteen cells describing viable research efforts in IS. Remark that while a research project may preferably cover multiple cells, it does not have to necessarily cover them all. In fact, "*although all four of these elements [research activities] should be present to some degree in design science research before the results of a project become a significant contribution [...] different forms of design science are likely to demonstrate some of these activities more than others. Researcher who focuses on building of artifacts will rely less on the building and verification of theory and vice versa*" [9].

Every cell of this matrix has specific requirements that may require different methodologies. Commonly accepted methodologies in the IS field include conceptual models, speculation, frameworks, library research, literature analysis, case study, field study, surveys, field or laboratory experiments, interviews, secondary data, and qualitative techniques like ethnography, action research and interpretive studies [10].

The primary purpose of this paper is to create information systems artifacts with the aim of facilitating the strategic analysis of the environment of an organization. In particular, this paper aims to create a conceptual model of the environment of an organization which can serve as a reference framework to facilitate the subsequent development of software-based management tools and information systems for the analysis of the environment. These tools are intended to support decision makers in the collection, organization, measurement, analysis and visualization of the key information about their organization's external environment which is relevant to strategic decision-making, hence allowing them to make better strategic decisions.

In terms of the design science framework of March and Smith, this paper deals with the intersections between the *build* research activities and all the research outputs, namely the *constructs*, *models*, *methods* and *instantiation* artifacts. In our research, we have also begun to tackle the *evaluation* activity by trying to evaluate the usefulness and applicability of the tools we have developed by applying them to two concrete environments in the mobile business industry.

3 Model

In this section we present a conceptual model of the environment of the enterprise aiming at providing a reference framework to facilitate the successive development of software-based management tools for the strategic analysis of the environment of an organization. These tools are intended to support decision makers in the collection, organization, measurement, analysis and visualization of the key information about their organization's external environment which is relevant to strategic decision-making, consequently allowing them to make better strategic decisions.

The selection of the relevant concepts and the construction of the model presented in this section correspond to a domain engineering effort. In fact, domain engineering aims to "*identify, model, construct, catalog and disseminate a set of software artifacts that can be applied to existing and future software in a particular application domain*" [11]. In our case the application domain is the environment of the organization and the software are tools developed in the next section.

Domain engineering typically encompasses three activities: domain analysis, infrastructure specification and infrastructure implementation [12]. In this section we focus on the domain analysis activity, which essentially consists in the identification, acquisition and analysis of the relevant knowledge about the domain with the purpose of producing a model of the problem domain. The domain model may then be used as a reference framework for the analysis of problems in the domain and as a specification for the specification and implementation of an architecture of reusable components.

It is suggested that it is appropriate to use an ontological approach to produce a specification of such a domain model [11]. This implies a commitment to provide a rigorous and unambiguous formal representation of a conceptualization of the domain of discourse under study. This requires not only to identify the relevant concepts pertaining to the domain, but also to provide a clear definition of their semantics, their interrelations as well as the set of constraints that impose a structure on the domain and constrain the possible interpretations of terms [13]. The creation of a domain model using an ontological approach encompasses two steps: ontology capture and ontology formalization. The former refers to the identification and definition of the relevant domain entities (such as concepts, relations, properties and roles), the latter refers to the explicit representation of the conceptualization captured in the preceding step using a formal language [11].

The ontology capture has been carried out by an extensive analysis of the literature pertaining to the various domains related to the different strategic aspects of the environment of the organization. Among them, the primary domains taken into consideration are the strategic management, strategic marketing, innovation, futures research and the various intelligence approaches. In a first step, we identified four perspectives that correspond to the key strategic aspects that appear in these literature streams as relevant for the analysis of the strategic environment of a business organization. These are namely the *market*, the *value proposition*, the *actors* and the *issues* perspectives. Then, in a second step, the more specific literature pertaining to these four perspectives was examined in order to identify the set of domain entities (concepts, properties and relations) needed for appropriately describing, assessing and analyzing them. Furthermore, the retained domain entities were refined based on the results of the application of the model to concrete environments in the context of mobile business to ensure its appropriateness and applicability to real life situations.

For the ontology formalization, we adopt the formalism proposed by the Entity-Relationship paradigm originally proposed by [14] and use the notation shown in Figure 1. This paradigm fosters the view that the real world is made of *entities* (things of interest) and *relationships* (associations between entities). Entities participate in a relationship according to an optionally specified role. Entities and relationships of the same type are regrouped into *entity sets* and *relationship sets,* described by a semantic definition and a set of *attribute-value* couples.

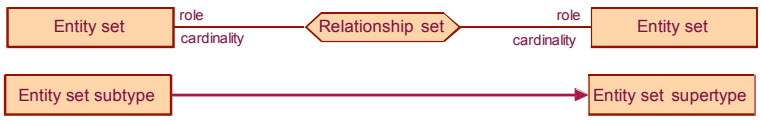

Figure 1: Graphical notation of entity-relationship concepts

As a first illustration of our model of the environment, it is useful to provide an overview of the general arrangement of the four perspectives that compose our model of the environment. These are namely the market, the value propositions, the actors and the issues perspectives, which are arranged as depicted in Figure 2 and are described thereafter in more detail in the corresponding models.

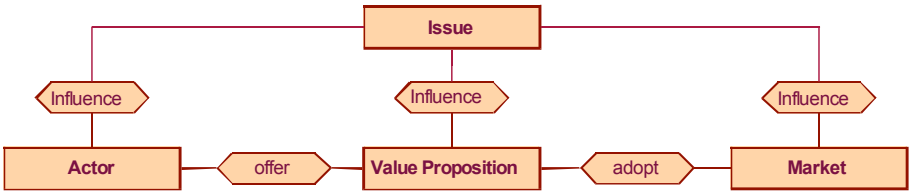

Figure 2: Overview of the environment model

While these perspectives give a rough categorization which is useful to get a broad idea of the content and structure of the global model, the following sub-models of the various perspectives constitute the essence of the model by specifying the actual constructs which compose the environment as well as the relationships between them.

3.1 Market Perspective

The market perspective focuses on the demand side of the organization's environment and deals with how the firm performs in the market from the customer standpoint. This perspective is strongly put forward by the marketing discipline, where the market that the organization wants to serve is commonly described as the natural starting point of the analysis of the environment of the firm. The reason is that the success of a firm essentially depends on its ability to create and maintain profitable relationships with customers, which in turn requires the firm to understand what customers need in order to be able to create suitable value propositions that meet these needs profitably. Moreover, the definition of the market determines what actors and issues are relevant in the analysis. The market perspective comprises the elements depicted in Figure 3 and shortly described thereafter.

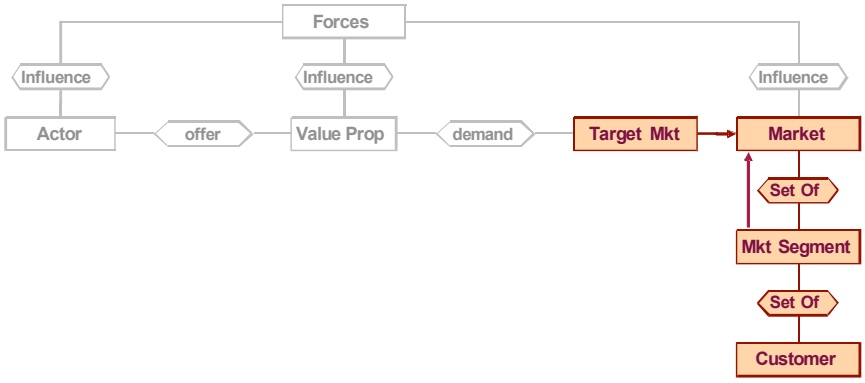

Figure 3. The market perspective sub-model

The central element of this perspective is the **market**. It can be defined as "a group of potential customers with similar needs who are willing to exchange something of value with sellers offering various goods and/or services, that is, ways of satisfying those needs" [15 p83] or more simply as "the set of all actual and potential buyers of a market offer" [16 p144]. A market is described by a meaningful *description*, its *boundaries*, defined in terms of product, needs, customer types and geographical characteristics [15 p88], and its *attractiveness*, estimated using a mix of criteria like market size, market potential, growth rate, average profitability and risk [17-19].

Because customers in a market tend to have heterogeneous needs and preferences, it is useful to split the market into more homogeneous groups of customers called **market segments**. These have been originally defined as "groups of customers that have similarities in characteristics or needs that are likely to exhibit similar purchase behavior" [20] or simply as "a group of customers who share a similar set of wants" [16 p279]. As a subtype of market, they inherit its properties and relationships. For this reason, market segments may be further split into smaller segments and may be chosen as target market. In addition, market segments are defined by the set of criteria (geographic, socio-demographic, psychographic and behavioural) that typify the customers in the segment and distinguish them from the others [16, p287-95].

Analysis of these elements requires identifying who are the potential **customers** that compose them and understand their behaviour. Customers are characterized by a set of needs, which may create motivations to buy specific types of value propositions to satisfy these needs (also called wants or desires) and finally end up in an actual demand when they are supported by the capacity to pay for them. It is also important to understand the set of valuation criteria and the corresponding valuation functions that they use to evaluate them and decide which value propositions to adopt.

Finally, after having estimated the potential profitability of the various segments and the capacity of the firm to serve them better than competitors, the firm can choose to focus on some particular segments, or even the whole market, as its **target market** and devise appropriate value propositions to offer them. The target market is simply defined as "the market that an organization decides to pursue" [16, p144].

3.2 Value Proposition Perspective

The value proposition perspective essentially focuses on the supply side of the market and deals with product innovation and competition. Analysis of the value propositions offered in the market is crucial because the organization is hardly alone in the market, but competes with many other firms trying to make business with the same customers by providing alternative value propositions addressing the same needs. Customers thus face abundant choice and buy from the firm that they perceive as offering the highest value. Because of this, the firm's value propositions must be developed and positioned with respect to those of its competitors in order to identify customers' needs that can be served better than they can and communicate their unique benefits to influence customers' adoption decisions favourably. Moreover, innovative value propositions and developments of the underlying technologies can be disruptive to the organization and must therefore be monitored carefully. The value proposition perspective comprises the elements depicted in Figure 4.

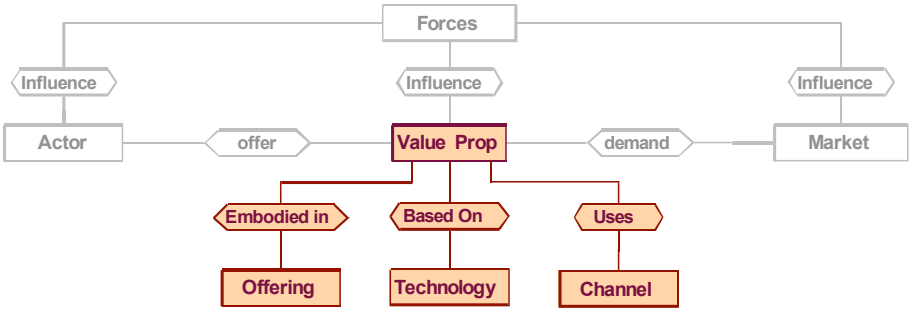

Figure 4. The value proposition perspective sub-model.

The *value proposition* itself is defined as the set of benefits offered to customers that deliver them value generated by the satisfaction of some of their needs.

An intangible value proposition is made physical by an *offering*, which commonly consists in a combination of products, services, information, and experiences.

The value propositions are conveyed to the customer through the *marketing channels*, which comprise the distribution, communication and service channels.

Finally, the value propositions are based on some underlying *technology*, which allow the value proposition to be produced and delivered to customers.

3.3 Actors Perspective

The actors perspective focuses on the external actors active in the organization's environment and essentially deals with the power relationship between them. This perspective is largely inspired by the strategic management and organization theory disciplines, and in particular by the seminal work of Porter on competitive strategy [4]. Understanding the roles of the different actors participating in a business system is crucial because of the impact that these actors can have on the environmental forces

and competitive conditions in which the organization deploys its activity and consequently alter its ability to achieve its objectives. Their analysis may allow the firm to anticipate their strategic moves and consequently be in a better position to react quickly and decisively, as well as to spot opportunities where the other actors are ill prepared to respond and are therefore likely to be more successful and last longer. The actors perspective comprises the elements depicted in Figure 5.

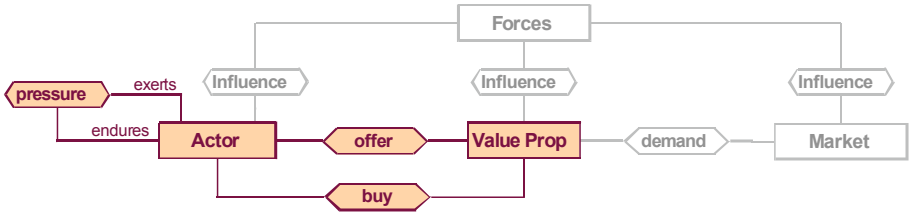

Figure 5. The actors perspective sub-model.

The core element of this perspective is the *actor*. An actor can be defined as an entity such as an organization that has a stake and plays a role in the environment of the organization. For this reason, we can also adopt the definition of stakeholder of Freeman who defines it as "any group or individual who can affect or is affected by the achievement of the organization's objective" [21].

Various *types of actors* must be taken into account. The organization itself is one of the actors. The other actors comprise those described by the five forces model [4]. These comprise all the existing and potential rival firms competing for the same customers (direct competitors in the same industry, substitute producers that address the same needs with different types of value propositions and potential new entrants) as well as the suppliers and distributors who operating in adjacent industries along the value system. Finally, other actors of the general environment who may influence the competitive conditions in which the other actors deploy their activity like regulators, technology suppliers and the financial community must be considered as well.

It has been suggested that an actors can be appropriately described by formalizing its *business model* [22]. According to [23], this essentially implies describing the actor's target market, the value propositions proposed to this market, the infrastructure used to create and deliver this value proposition and the resulting financial aspects.

In addition to describe the actors' business models individually, it is also important to assess the relationships among them. The value chain framework [24] deals with the *offer and buy relationships* between actors stemming from the exchange of objects of value. In effect, the value system in which an organization participates comprises a set of actors along the supply chain that perform each a set of value-adding activities in their internal value chain and are connected by the exchange objects of value (i.e. value propositions).

These exchanges are not the only relationships existing between actors. In fact, as suggested by the five forces model [4], the actors are linked to each other via *pressure relationships* which may stem from an uneven bargaining power in the exchange of objects of value, competitive threats or other kinds of influence means. In particular, competitors and substitute producers exert a pressure due to their rivalry for the same

customers. Its intensity depends on factors like their number, product differentiation, cost structure, customers' switching costs, high strategic stakes and exit barriers. The pressure of new entrants depends on entry barriers like economies of scale, capital requirements, costs disadvantages, access to distribution channels and materials, legal protections and expected retaliation. The pressure of suppliers and distributors stems from their bargaining power relative to the firm; this depends on the number and size of firms in each industry, whether the firm is a significant fraction of their business, the criticality of the good exchanged, the availability of substitutes, switching costs and the threat of forward or backward integration. Finally, other actors may exert other types of pressure. For instance, regulatory authorities may set rules affecting the other actors and at the same time endure their lobbying pressure. Remark that these pressure relationships are also sometimes called influence relationship by [25].

3.4 Issues Perspective

The issues perspective focuses on the main uncertainties about the future evolution of the general environment of the organization. Analysis of this perspective is important because the long-term nature of strategic decisions compels the firm to consider the possible evolutions of the conditions in which these decisions will deploy their effects.

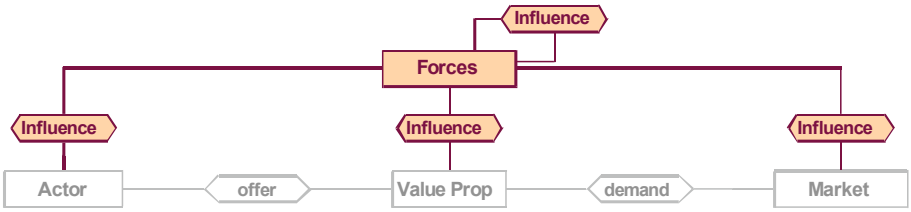

Figure 6. The issues perspective sub-model.

Issues can be defined as open questions, forces, trends, events or other forthcoming developments whose realization can have a major impact on the future conditions of the environment in which the organization and the other actors deploy their activity and consequently affect their ability to achieve their objectives. Alternatively they can be seen as the structural variables which are determinants of the future evolution of the environment [25]. The issues are characterized by a meaningful description and the range of possible outcomes.

The issues may arise in the various domains of the general environment. These are namely the socio-demographic, technological, economic, ecologic and political environment of the firm described by [26].

As suggested by [25], issues can exert an *influence* between each other in that the outcome of one issue may affect the outcome of another. It may be useful to assess the direction of the influence (i.e. positive or negative) and its intensity. The existence of these influences, the company must pay attention to the potential interactions between issues, as this may lead to the emergence of new opportunities and threats.

Actors-issues models such as those described by [27] suggest that the strategic action of the various actors in the environment may also *influence* the outcome of an issue, at least to a certain extent. The effect of an actor on an issue can be described by three values called position (i.e. its preferred outcome for the issue), salience (i.e. the relative importance of the issue to the actor) and clout (i.e. the power of the actor to influence the issue's outcome). At the opposite, we can add that the realization of a certain outcome for an issue may in turn exert an influence on the actors by constraining their initiatives and altering their respective power relationships.

Issues also exert an *influence* on the market as recognized by [16] when speaking of the forces of the macro-environment. Issues may hence influence the market in terms of its composition and attractiveness, customer needs, wants and evaluation criteria, thereby influencing their adoption decisions.

Finally, issues may also directly *influence* value propositions, typically by affecting the evolution of the underlying technological possibilities.

4 Tools

In the previous section, we presented the concepts and models of the four main perspectives that represent the key aspect that must be assessed in a strategic analysis of the environment. In this section, we propose a set of tools that may be used to assess, analyze and visualize information about these different elements. This section provides a sort of environmental toolbox where decision makers can find some tools they can use for analyzing some aspects of their environment. The categorization of the tools in the different perspectives is somewhat arbitrary. In fact, most tools integrate aspects of various perspectives. It is nevertheless useful to provide some guidance in finding the most appropriate tools for a given environmental analysis problem.

4.1 Market Perspective

There are two types of data sources should be considered to analyze this perspective. An organization can exploit the available internal information flows obtained not only by various employees (e.g. sales force, staff, managers) but also by the diverse internal record systems, such as sales reports, customer database, and transaction histories. These data are usually gathered, stored and analyzed by using so-called business intelligence tools, data warehouses, and data mining tools.

The organization can gain some knowledge of the market through external data such as business, governmental or academic studies and publications. There are also market surveys, published statistics (e.g. demographics, economics, industry) that could be good sources of data for analysis purpose.

One traditional way of investigating customer needs is by directly asking users to elicit their needs. For this purpose, there is a variety of quantitative and qualitative methods including surveys, interviews, customer visits and focus groups [28]. Unfortunately, these methods are more suitable for descriptive research than actual

user needs detection. This is primarily due to the fact that users do not know what they really want. Moreover, they are susceptible to be influenced by outside influences.

An alternative consists in focusing on the user's behavior. There is a multitude of methodologies from different research disciplines such as diffusion studies (studying the link between the characteristics of an innovation and its diffusion process), adoption studies (focusing on the individual user's decision to adopt a particular service), uses and gratification studies (studying the gratifications sought in adopting a new service), domestication studies (studying the societal consequence of domestication of everyday life technology), observational research (ethnography, participant, indirect observation, usability studies) and experimental methodologies (e.g. simulated shopping experience in a controlled environment) [29, 30].

Companies must also understand the possible market evolution. There is a multitude of forecasting methods, such as various extrapolation techniques, probabilistic forecast, scenarios, expert opinion, delphi, buyers' intentions survey [31].

4.2 Value Proposition Perspective

To analyze the value proposition perspective, we propose to use a set of tools varying from technology roadmap, innovation diffusion analysis, the disruption framework, multi-criteria decision making methods.

Interesting tools that enterprises can use to keep track at the same time of the market, product and technology evolution are technology roadmaps. These are "*a powerful technique for supporting technology management and planning, especially for exploring and communicating the dynamic linkages between technological resources, organizational objectives and the changing environment*" [32]. Although roadmaps can take various forms [cf. 32], the most common is a time-based chart comprising a number of layers that illustrate the evolution of technologies, products and markets over time and show the linkages between them. The benefit of this technique is that "*the roadmap enables the evolution of markets, products and technologies to be explored, together with the linkages and discontinuities between the various perspectives*". It does indeed show how the various generations of a technology follow one another, the potential emergence of alternative and disruptive technologies, how these technologies may be translated into products and how these can be targeted to existing markets or even create new ones. Actually, roadmaps "*can act as a radar for the organization to identify potentially disruptive technologies and markets*" [32].

Another promising approach is to assess the disruptiveness of emerging value propositions by comparing them to the ordinary ones on a number of dimensions [33]. By doing such analysis, the organization could identify and measure a potential disruption on the market. Therefore, the incumbent would have the chance to be prepared to retaliate if there is a risk of disruption.

One other methodology is to take advantage of the power of analysis of multi-criteria decision making methods (MCDM). This approach is largely concerned with the deployment of systematic methods to help address problems characterized by incomparable objectives, multiple stakeholders and conflicting interests [34], which

are typically the type of context in which an organization evolves. The basic idea is to analyze the current market state using multiple actors' preferences based on their own criteria. Using this technique, it is also possible to find a consensus based on each stakeholder evaluations. The expected outcome is a good insight into the possibility of a value proposition to be adopted by the market. In addition, some researchers also suggest that there is a real potential of the use of MCDM for technology foresight activities [35]. In other words, this approach also gives a good base for building scenarios about the future of a value proposition.

4.3 Actor Perspective

Understanding the roles of the different actors participating in a business system is essential because of their central position in shaping the future environment state.

For assessing the role of the key players, it is recommended to briefly but clearly describe their business models. Although research on formalizing business models is young, some pioneering software tools have already been envisioned to deal with this task. In particular, the business model ontology and its corresponding modeling language (BM2L) allows the description of a business model based on the description of the actor's value proposition, its target customers, its infrastructure (activities and partnership network) and its financial aspects [36].

Once the business model of the different actors have been described, it is necessary to review the relationships and interactions among them as well. The well-known value chain framework [24] highlights the relationships stemming from the exchanges of objects of value between the actors along the value system (or supply chain). The value system is seen as a series of interconnected actors who perform series of value adding activities defined by its internal value chain configuration; the value chains of the actors are linked in that the output of the upstream actor's value chain is the input of the downstream actor's value chain, until it comes to the customer. While this framework is mainly adapted to manufacturing, there are also extensions suited to service providers and brokering activities [37]. The E^3value modeling language and the associated prototype proposed by [38] constitutes an appropriate software-based tool that allows the user to formalize the exchanges of value between actors and to represent the value system.

While these methods enable us to describe the relations between entities stemming from exchanges of value, the pressure relationships between actors that must be taken into account as well. These have been brilliantly illustrated by Michael Porter's five-forces framework [4], which advocates the important effect on the firm by the pressure of existing competitors, suppliers, buyers, new entrants and substitute products producers. Furthermore, this framework can be extended to include other categories such as players in the regulation and technology areas.

Finally, the theory of stakeholder identification proposed by [39] can be used to identify the most important stakeholders for an organization by characterizing their pressure relationships and estimating their magnitude based on a combination of the power, legitimacy and urgency of their claims.

4.4 Issues perspective

Since the main goal of environment analysis is to anticipate the potential changes that occur in it, a company must look beyond the current market state and assess the most important future prospects of its environment. One way to do this is to identify and assess the major issues and trends that may affect the environment.

While trends indicate the most likely evolution, issues determine possible departures from these trends towards alternative futures. Obviously, both elements must be considered. Issues can be seen as forthcoming developments which are likely to have an important impact on the ability of the organization to achieve its objectives [40].

Identification of the relevant issues is a difficult task while mostly a matter of judgment. It often relies on the opinion of a group of experts. A number of methods can help by fostering creativity (e.g. brainstorming, assumption reversal, and analogies), consensus (e.g. Delphi, nominal groups) and collaboration (e.g. group support systems).

On his side, Godet proposes a systematic method for identifying, classifying and prioritizing issues. This method, called MICMAC, is based on the concept of influence and dependence between issues and classifies issues as dominant, relay, dominated and autonomous [25].

An interesting set of tools tries to study actor-issues relationship. These basically consider the environment as a game between multiple actors that try to influence the factors (i.e. the issues) that govern its evolution either by mobilizing their resources to influence the issues outcome directly or indirectly by influencing (i.e. negotiating with) other actors.

Only a few actor-issue methods stem from various disciplines and provide different information. The MACTOR method [25] originates from a systemic perspective and provides an aggregate overview of the system under study through a number of computations on several input matrices. Allas and Georgiades [41] developed a simpler model to support negotiators, which essentially consists in a set of graphs that provide strategic information such as position, salience, and clout. Other methods tackle the same problem based on game theory using expected utility calculations [42].

5 Prototypes

In this section, we present two decision support systems prototypes developed in our research group. They cover several elements introduced previously. Specifically, they deal with parts of the environmental model and implement a selection of the original or improved versions of the techniques exposed in the previous sections. Their main usefulness is to provide an appropriate interactive interface and an improved visualization, which makes easier to solve specific problems rising from environment scanning activities. These activities would be very difficult to conduct without a computerized tool. The first prototype is a decision support systems dealing with the evaluation of alternative technologies using a multi-stakeholder multi-criteria

decision-making model. The second is negotiation support system aiming at aiding negotiators in multi-issues and multi-actor situations.

5.1 A DSS for Multi-stakeholder Multi-criteria Market Assessment

This prototype aims at evaluating a set of value propositions from the point of view of the involved stakeholders using a MCDM method called Electre. The outcome of this method is a matrix of outranking relations, which seeks to compare decision alternatives. In other words, a_i outranks a_k when the information obtained from the decision maker's preferences safely justifies the proposition that a_i is at least as good as a_k. This outranking relation can also be explained by two further concepts: (i) the presence of concordance, (i.e., for a sufficiently important subset of evaluation criteria, a_i is at least weakly preferred to a_k), and (ii) the absence of discordance, (i.e., among the criteria for which a_k is preferred to a_i there is no significant discordant preference that would strongly oppose any form of preference of a_i over a_k).

The motivation of developing such a tool comes from the need to conduct easy sensitivity analysis without having to recalculate everything manually. Moreover, the graphic user interface (GUI) of this DSS was built so as to improve the visualization of the outcome. Different colors were used to increase the visibility of the different evaluation and result numbers. As this prototype is still at an early stage of development, there are still some improvements to perform. Therefore, this IT artefact is in constant evolution, as more features will be added shortly (e.g. sensitivity analysis module and scenario-building assistant).

This prototype also implements a group decision feature that was proposed by [43]. The idea is to introduce the different evaluations in the model and run the calculation for each stakeholder. The group decision outcome can be found by comparing the different concordance and discordance matrix. This operation is automatically calculated by our DSS. The outcome of this computation is a general consensus that is satisfactory to all players based on their evaluations.

Related to the previously described perspectives, this prototype embeds most of the perspectives presented above. In fact, we take into account the actors and the value proposition as we evaluate alternatives from each stakeholder's point of view. Moreover, we cover the market perspective as the proposed consensus establishes the preferences of the consumers. We assume that a certain value proposition could only be successful if each of the stakeholders mutually agrees on its good performance.

We already used this IT artefact in the context of the mobile payment market. After conducting cross-industry interviews with experts on mobile payments in Switzerland [44], we represented their appreciation of the different alternatives into more quantitative evaluations. After running our analysis, we obtained a relatively good picture of the current mobile payment market. Therefore, we could confirm some of the trends observed in this industry. Figure 7 illustrates this analysis conducted with our DSS.

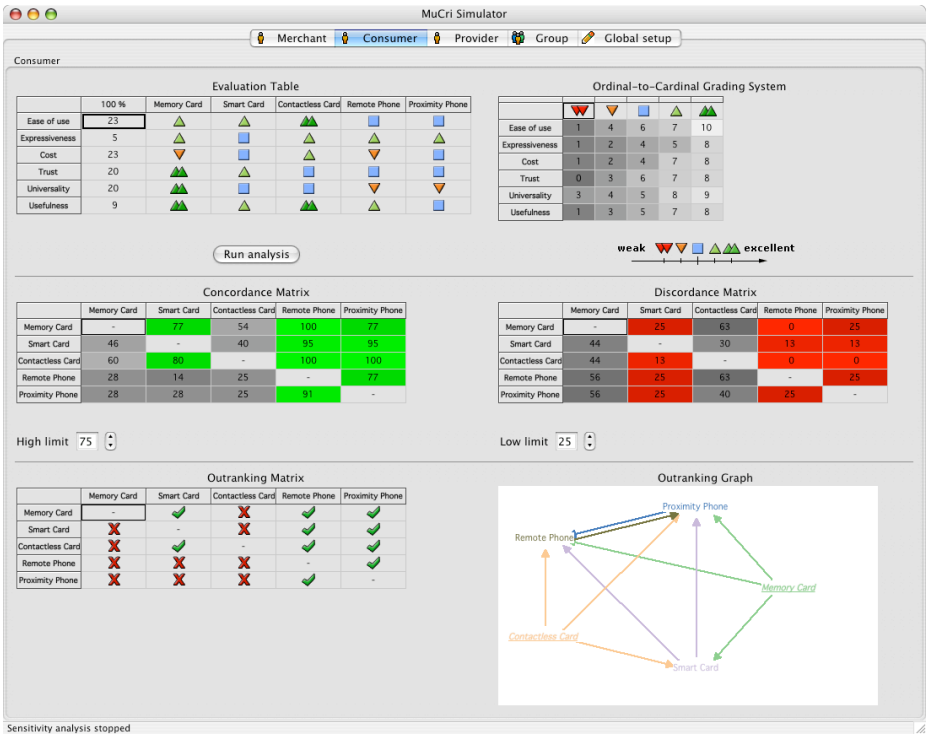

Figure 7. A screenshot of the MCDM DSS prototype for evaluating innovative value propositions in the mobile payment arena.

As observable in Figure 7, the evaluation table lets the user enter the evaluations of the technologies on the various criteria and the relative weights of the latter. The concordance and discordance matrixes evaluate respectively how much a solution is superior/inferior to another. Finally, the outranking relations are visualized in the outranking matrix and outranking graph. The tool allows these elements to be visualized for the various groups of actors involved (e.g. merchant, provider, consumer) and aggregate their opinion to highlight whether there is a consensus on some elements (group decision).

5.2 MASAM

The second prototype we propose is a multi-issues and multi-actor negotiation support system called MASAM (Multi-issue Actor Strategic Analysis Model), which is presented in more detail in [45]. It builds on part of the issues and actors models presented in section 3.3 and 3.4 respectively. In particular, it uses the following concepts and relations:

Figure 8. The part of the model underlying the MASAM prototype

For the purpose of this tool, the *actors* to consider are those that have an interest in the negotiation process and have the ability to affect its outcome by influencing either other actors or issues, while the *issue* can pragmatically be seen as the various aspects related to the problem being discussed. The relationship between an actor and an issue can be described by three values called position (i.e. its preferred outcome), salience (i.e. its relative importance) and clout (i.e. its power to influence). The relationship between actors is characterized by the *influence* that one actor has over another.

Based on these concepts we have taken two complementary methods dealing with the relationships between actors and issues identified in section that we designed a prototype that integrates the possibilities offered by the two models. The first one is the MACTOR method [25], which attempts to consider the collective effects of the actors' strategies on the issues determining the evolution of their environment. This method analyses the influence between actors as well as their position and salience on the issues. It provides a global vision of the relative importance and possible outcomes of the issues, as well as the relationships of power, alliances and conflicts between actors. The second one is a multiparty negotiation support model developed by [41], which analyzes the position, salience and clout of actors on issues to give information about the expected outcome of negotiation and the possible deals with other actors.

The prototype we propose essentially combines the inputs of the two methods with the aggregative analyses inspired by the former method and the intuitive graphical representations of the latter. Furthermore, while the features of both methods are replicated by MASAM, which is capable of providing all the information obtainable from them, it also allows the generation of additional information and illustrations that allow further interesting interpretations of the basic data. In particular, MASAM allows the analysis of the influences between actors, their respective power; their potential alliances and conflicts, the relative importance of each issue, their expected outcome and the dissatisfaction of each actor with this outcome. The details of the computations done by MASAM to generate this information can be found in [45].

A decision support system has been designed to make the necessary calculations and offers intuitive graphical representations of the different analyses. The user interface of the system is depicted in the following figure, illustrated with a sample of data gathered during an application of the model to the Wireless LAN Internet Service Provider industry as described by [45].

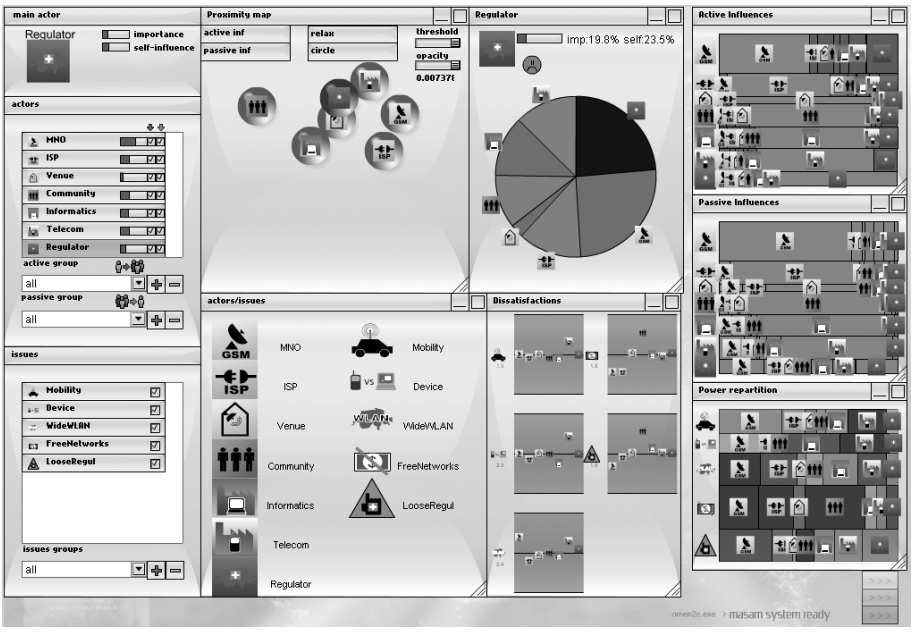

Figure 9. A screenshot of the MASAM prototype user interface and its basic analysis tools

Figure 9 provides an overview of the visualization and analysis tools offered by MASAM. In particular, the active and passive influence graphs depict each actor as an horizontal bar, providing an overview of the relative power of the actor (the height of the bar) and the influences it exerts or are exerted on them by other actors (the width of the areas of the bar corresponding to the other actors). The dissatisfaction chart represents the expected outcome of each issue and the dissatisfaction of actors which may want a higher or lower outcome. The power repartition graph shows each issue as a bar, with its relative importance (height of the bar) and the power of actors to influence its outcome (the width of the areas of the bar corresponding to the actors). Finally, the proximity map shows the relative similarity of the actors which may provide an idea of the potential coalitions and alliances.

6 Conclusions

Environmental analysis is a difficult task, which demands the analysis of a huge amount of information: many elements have to be assessed and integrated to give strategists a solid base upon which make their decision. For this reason, a decision support system supporting decision makers in this activity would be very valuable.

In this paper, we have attempted to deal with this problem from a decision systems point of view. In particular, following a design science research framework [8] we have tried to provide a set of reusable artifacts (constructs, models, methods and

instantiations) with the goal of facilitating the subsequent development of software-based tools for conducting a strategic analysis of the environment of an organization.

In particular, we have identified four perspectives that correspond to the essential aspects that must be taken into account in a comprehensive strategic environment analysis. For each perspective, we have defined the collection of the relevant elements (cf. construct artifacts) needed to analyze it and proposed a conceptual model or ontology (cf. model artifact) integrating these element and expressing their relationships. Then, we proposed a selection of analysis techniques and tools (cf. methods artifacts) that an organization could use in order to assess, analyze and visualize the information in these different perspectives based on the previous elements and models. Finally, we illustrated two prototypes (cf. instantiation artifact) that allow a partial analysis of the environment that tries to integrate some of the preceding elements, models and techniques.

The proposed artifacts can be seen a first step towards the conception and development of decision support systems which assists the extensive analysis of the environment from the three mentioned perspectives. In the future, we hope that the ideas exposed in this paper will support and stimulate the development of a range of tools and decision support systems for assessing an organization's environment in a comprehensive and systematic manner.

As a final note, we believe that the presented artifacts can also be a good support for building scenarios which are suited to cope with high levels of uncertainty and complexity of the current environmental context of many industries. In particular, we plea for a modified scenario planning methodology which would take advantage of the results of an environmental analysis to develop more creative, grounded and coherent future scenarios.

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