Multidimensional Analysis Through Argumentation?

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Contributions from a Short Food Supply Chain Experience

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Abstract. The paper introduces a method to evaluate a short food supply chain based on argumentation. It defines an analytical argumentation system using contexts, and introduces indicators to perform analysis. It proposes an evaluation of the experimental device created to observe the short food supply chain mechanisms, based on this analysis methodology. It concludes on the feedback learnt from this analysis, from methodological and application viewpoints.

Keywords: Multicriteria modeling · Risk benefit analysis · Viewpoints

1 Introduction

In recent food-related concerns, short supply chains [3, 6] are considered as a new means of supply that is determined by the close proximity of production to consumption, both geographically and relationally. In 2011–2012, an experimentation was carried out in the department of Hérault in France, to test the feasibility of using short supply chains for the provision of food aid. The aim was to provide a proof of concept, the study model being the fruit and vegetable supply of the Hérault branch of the association '*Les restaurants du coeur - relais du coeur*' (denoted AD34).

A need for explanation, analysis and rationalization of the collected results motivated the formal approach proposed in this paper, based on abstract argumentation [1, 5, 7]. In [11], the relevance of the argumentative approach was highlighted regarding cognitive considerations. Recently, several works proved its relevance in social-related concerns, food systems, chains, policies and controversies [2, 4, 8–11]. In the present paper, we revisit argumentation systems to question the meaning of basic notions in a concrete case: What does an extension mean practically? Are rejected arguments not to take into account, as usually considered in the literature? What does the credulous and skeptical semantics express? How can they be exploited from an application point of view? Can argumentation systems enhance the understanding and analysis of the situation?

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2 The Experimental Device

The partners involved in the implementation of the device were AD34, Somimon/Mercadis – the managers of the Greater Montpellier National Wholesale Market (MIN) – and the "Innovation" joint research team. In 2011–2012, the dynamic of food supply for the AD34 distribution campaign was monitored chronologically, including all actors: wholesalers, the producers, AD34's volunteers and those who received aid from AD34. The first phase of the evaluation defined the dimensions to be analyzed in the study, namely, the technical, (logistic), economic (added value for producers and wholesalers), social (relations and the sharing of information between stakeholders) and participative (involvement of the actors) dimensions.

In the second phase, information was collected: semi-structured interviews were conducted with producers participating in the device (10 interviews with 8 producers), groupings of producers, coordinators of the agri-food networks in MIN (4 interviews), the two wholesalers (4 interviews), the volunteers responsible for receiving the fruit and vegetables from AD34's warehouse (4 interviews), and other AD34 volunteers (10 interviews with 10 volunteers responsible for the distribution centers). Interviews were conducted throughout the 16 weeks of the distribution campaign.

Moreover, AD34 conducted surveys shortly before the end of the campaign. These were intended for volunteers at the distribution centers and recipients of the food aid, essentially concerned with the technical dimension. For volunteers, all the centers were covered, with a response rate of 77% covering 56 volunteers. For recipients of aid, the survey was conducted on a sample of 10 centers that represented various capacities for aid distribution and for the population group served. 122 people responded. The results of these interviews and surveys provide input for this paper analysis.

3 Formalizing Arguments and Attacks

Arguments discussing the success or failure of the device are presented in Table 1.

Table 1. Arguments about the interest of the device

Arg.	Description	Pro/con	Dimension
A	The device is well accepted when it induces no price loss for producers compared to the classical system	pro	economical
B	Products that are hard to sell in the classical system require little effort for producers in the device	pro	economical
C	Non-standard products are difficult to sell in the classical system	pro	economical
D	Overproduction due to climatic reasons is difficult to sell in the classical system since it leads to an imbalance between supply and demand	pro	economical
E	The device failed when it turned out to be too adverse compared to the classical system	con	economical

(*continued*)

Table 1. (*continued*)

Arg.	Description	Pro/con	Dimension
F	The device failed when it was too adverse in terms of price	con	economical
G	The device failed when it was too adverse in terms of storage capacity	con	technical
H	The device was a success even with low prices when it took place in a context of low demand, combined with an advantage for producers	pro	economical
I	Reduced transportation cost is a possible advantage	pro	economical
J	The sale of non-standard (e.g. large-size) products is a possible advantage	pro	economical
K	Motivation to participate in a solidarity project is a possible advantage	pro	participative
L	Keeping good business contacts with the wholesalers is a possible advantage	pro	social
M	The device failed when it did not take into account the quantities available on the local market	con	technical
N	For some products, the device was a success despite the inadequacy of the planned dates to the reality of the local market, thanks to the wholesalers' good knowledge of the local market, leading to a new planning proposition	pro	social
O	Large-size products brought logistical difficulties to the volunteers of the distribution centers	con	technical
P	Local fresh products facilitated the volunteers' work from a logistical viewpoint, by avoiding them to sort damaged products	pro	technical
Q	The disposal of products was achieved in reduced time	pro	technical

We can notice that arguments C and D are particular cases of argument B, and that the three of them (B, C, D) disagree with argument A since they express that price is not the only element that may lead to the success of the device. Thus we can note that the attack relation R contains the following attacks: (B, A), (C, A), (D, A).

Arguments I, J, K, L are different variations of argument H. In this set {H, I, J, K, L} all arguments contradict with the prior argument F. Thus we can add the following attacks to the attack relation R: (H, F), (I, F), (J, F), (K, F), (L, F).

Argument N is a counter-example of argument M based on a social benefit of the device. Thus we can add to the attack relation R: (N, M).

Argument O mentions a technical difficulty associated with large-size products. This contrasts with argument J which considers the handling of non-standard products as a positive feature of the device. It also contrasts with argument A which tends to reduce the difficulties encountered by the device to the possible price loss. Thus the following attacks can be added to R: (O, A), (O, J).

Moreover, arguments O and P both focus on logistical aspects of the device. O is a negative one, since it addresses the necessity of cutting large-size products, which is not only time-consuming but also implies space and equipment to do it. On the

opposite, P is a positive aspect, since the sorting of damaged products can be avoided in the device. Thus a mutual attack between O and P is declared in R: (O, P), (P, O).

Finally, argument P highlights waste reduction, which counterbalances the economic argument F. Thus we can add to the attack relation R: (P, F).

4 Proposed Model and Indicators

The framework we propose includes several ways of organizing the set of arguments in contexts. Each way provides a partition of A.

Definition 1 (Analytical Argumentation System). An Analytical Argumentation System is a tuple ASS = (A; R; C1 … Cn) where:

- A is a set of arguments,
- $R \subseteq A \times A$ is an attack relation,
- each Ci is a partition of A. It is thus a breakdown of the set of arguments A into subsets called contexts. By definition of a partition, the set of contexts c belonging to Ci satisfies: ($\cup c \in Ci\ c = A$) and ($\cap c \in Ci\ c = \varnothing$).

Several indicators are then associated with the AAS in order to make an analysis.

Definition 2 (Indicators). Given an AAS, the following indicators are computed.

Indicators concerning the polemical status of the system

Let Rej denote the set of rejected arguments, according to [5].

- Ratio of rejected arguments ($|Rej|/|A| \in [0;1]$).
- Number and proportion of rejected arguments per context
- Number of internal and external attacks towards rejected arguments

Indicators concerning the origin of divergent viewpoints

Let Skept the set of skeptically accepted arguments and Cred the set of credulously accepted arguments, according to [5].

- Ratio of skeptically versus credulously accepted arguments ($|Skept|/|Cred| \in [0;1]$).
- Number and proportion of strict credulously accepted arguments per context
- Number of internal and external attacks towards strict credulously accepted arguments

5 Analysis and Discussion

An AAS = (A; R; C1) is instantiated with the following elements:

- A contains the arguments from A to Q described in Sect. 3;
- R contains the attacks indicated in Sect. 3;
- a partition C1 is defined according to the dimensions studied in the device, thus C1 = {economical context, technical context, participative context, social context}.

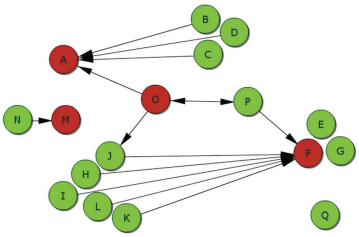

Fig. 1. First preferred extension (Color figure online)

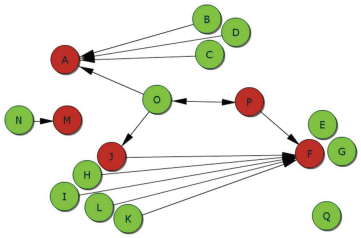

Fig. 2. Second preferred extension (Color figure online)

Figures 1 and 2 show the two preferred extensions (see [5]) of the Dung-style argumentation system AF = (A, R). The arguments displayed in green belong to the extension, those in red do not. We have Rej = {A, F, M} and Cred\Skept = {J, O, P}.

Indicators concerning the polemical status of the system

– Ratio of rejected arguments ($|Rej|/|A| \in [0;1]$).

3 arguments out of 17 are rejected. The ratio of rejected arguments is thus 0.18, which means that a minority of arguments (18%) are attacked without being defended. The first two arguments (A and F) express that the device has to be economically viable to be of interest, the third one (M) claims it has to be aware of the market quantities. Although these arguments express a practical view of the market reality, they were rejected because they needed refining. In summary, the system shows a moderate polemic linked to the refinement of initial common-sense arguments about consideration of the market reality.

– Number and proportion of rejected arguments per context

Figures 3 and 4 show the two preferred extensions partitioned according to C1. The contexts of C1 contain, respectively, {9, 5, 1, 2} arguments, showing the prevalence of economic and technical motivations. The numbers of rejected arguments per context are respectively {2, 1, 0, 0} and their proportions {22%, 20%, 0%, 0%}. We can conclude that the polemic mainly regards economical concerns, and secondarily technical concerns. Indeed, among the rejected arguments, A and F deal with prices, whereas M deals with market quantities.

– Number of internal and external attacks towards rejected arguments

In C1, the numbers of internal attacks (i.e. from the same context) are respectively {6, 0, 0, 0}, and the numbers of external attacks (i.e. from other contexts) are {4, 1, 0, 0}. Surprisingly, economic arguments are mainly internally attacked by other economic arguments, which tends to demonstrate that initial reluctances to consider a possible economic viability of the device had to be revised in the light of the practical implementation of the device and specific conditions (e.g. reduced transportation cost, context of low demand, etc.). External attacks to the economic arguments are quite balanced between the different other contexts (2 from the technical context, 1 from the participative context, 1 from the social context). Their meaning is that economic

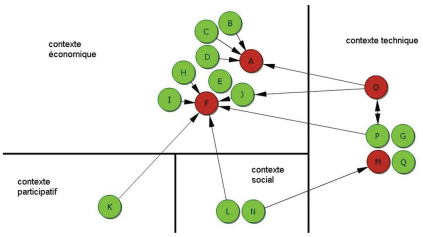

Fig. 3. First preferred extension partitioned according to C1 (the contexts are the dimensions of the study)

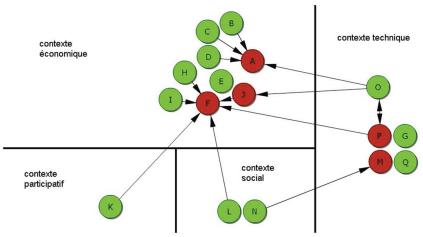

Fig. 4. Second preferred extension partitioned according to C1 (the contexts are the dimensions of the study)

drawbacks can be counterbalanced by benefits in other concerns (e.g. keeping good business contacts with wholesalers, as expressed by the social argument L). The social context, although containing only 2 arguments, is highly involved in the polemic against rejected arguments, since both social arguments attack a rejected argument. For instance, the technical rejected argument is only attacked by a social one.

Indicators concerning the origin of divergent viewpoints

– Ratio of skeptically *vs* credulously accepted arguments ($|Skept|/|Cred| \in [0;1]$).

14 arguments are credulously accepted, among which 11 are skeptically accepted. The ratio of skeptically versus credulously accepted arguments is 0.79, which expresses a rather consensual debate (79% consensual), although a 21% divergence remains, due to the three arguments that are strict credulously accepted (J, O and P).

The divergence regards two points: (i) whether or not the sale of non-standard size products is a possible advantage, with a divergence between J and O, and (ii) whether the device brings logistic advantage, with a divergence between O and P.

– Number and proportion of strict credulously accepted arguments per context

In C1, the numbers of strict credulously accepted arguments per context are respectively {1, 2, 0, 0} and their proportions {11%, 40%, 0, 0}. We can conclude that the technical context plays an important part in divergences. Indeed, among the strict credulously accepted arguments, O and P are technical and deal with logistical issues, whereas J considers the device as an economic opportunity for non-standard products.

– Internal and external attacks towards strict credulously accepted arguments

In C1, the numbers of internal attacks (i.e. from the same context) are respectively {0, 2, 0, 0}, and the numbers of external attacks (i.e. from other contexts) are {1, 0, 0, 0}. These figures provide important information: divergences in viewpoints are all related to technical considerations. Indeed, there are no internal discordances except for the technical context, which has an internal dilemma about the logistical benefit of the

device (arguments O and P). Moreover, there is only one external attack directed against the economic argument, and this attack is again coming from the technical context (argument O). Thus the technical argument O appears to be a backbone of the divergences expressed in the system.

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