No organization without obligations: How to formalize collective obligation?

Lambèr Royakkers and Frank Dignum*

Abstract

Multi-Agent Systems are computational systems in which a collection of autonomous agents interact to achieve a certain task, for example to fulfil an obligation directed to the whole group, i.e., a collective obligation. Since, such a collective obligation is beyond the capacity of an individual agent, the agents has to communicate, cooperate, coordinate and negotiate with each other, to achieve the collective task: the fulfilment of the obligation. In this paper we discuss and formalise collective aspects of obligations and commitments. Collective obligations are analysed and formalised in a deontic logic framework. The notions of individual and collective commitment are defined to specify which individual has the responsibility to fulfill an 'internal' obligation as part of the collective obligation. In DAI theories of organisations ([5]), it is emphasized that 'commitment' is a crucial notion to analyse a collective activity or the structure of an organisation. In this paper we gave a first attempt to formalise the notion of commitment to determine which plan has to be followed to achieve a joint goal, i.e. the fulfillment of a collective obligation by using several concepts as commitment, delegation and authority-relation.

keywords: deontic logic, commitment, social agents, DAI-theory

1 Introduction

The aim of this work is to introduce some notions of commitment and group structure by delegation to determine the relation between individual agents and their collective obligation to accomplish some goal. A collective obligation is an obligation aimed at a group of agents (addressees); i.e., the group as a whole is obliged to achieve a certain task. E.g. a program committee may have the collective obligation to review all submitted papers before a certain time. We are interested to explore how this collective obligation translates into individual obligations for the program committee members, e.g. review two or three papers, and the extra obligations for the program chair to divide the papers and

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monitor the process and make final decisions. In [20], the collective obligation is formalized in a framework of deontic logic, which gives the opportunity to express which agent (or which group of agents) has the responsibility to bring about a certain situation (to express group liability, e.g. liability for a trading partnership) and to express the relation between the agents of a group. Such an approach is necessary for a good definition of our concepts and for developing a formal theory of groups, organizations, and collective actions, since there is *no Organization without Obligations*.

However, in the theory developed in [20] we cannot express the individual responsibility that follows from the task to achieve the fulfilment of the collective obligation. A consequence is that we cannot indicate which individual is responsible for a violation of a collective obligation. To deal with this, we will investigate the notion of commitment in the context of collective obligation. Commitment links the agents with the joint goal (i.e. the fulfilment of the collective obligation), so that we can express to whom such an agent is committed to and to what that agent is committed to (see [1, 4, 18]). The core of such a commitment is delegation. Delegation is a basic ingredient for joint intentions, true cooperation and team work. It can be used for a plan-based definition of tasks, which have to be achieved by the agents of the group. In fact, in organization theories of DAI ([5]), negotiation systems and cooperative software agents, it is emphasized that 'commitment' is a crucial notion to analyse a collective activity or the structure of an organisation, through the allocation of some task by a given agent to another agent. This is basically correct, although is not general enough: it is already restricted to the most complex (less basic) forms of commitment and delegation. We will start from more basic notions. With such a kind of analysis we gain an insight into different kinds of organization, and consequently for different kinds of commitment, and then for different ways to solve conflicts, both intra- and inter- agents. For instance, how to intervene when one of the agents decides to abandom the group or the common plan, or omits his task.

In this paper, we will still remain very generic, we do not deal with individual motivations, restrictions on the groups of agents, etc. It has to be seen as a first attempt to combine some notions (collective obligation, commitment and delegation) to formalise the individual responsibility to achieve a joint task, which gives new expressive power and is, therefore, subject to new intuitions.

This paper is structured along the following lines. In section 2, we discuss the collective obligation. Here the deontic operator O is relativised for groups of agents. Section 3 presents several notions of commitment. Delegation, the core of social commitment, will be discussed in section 4. The plan, which indicated how to achieve a complex task by a group, will be introduced in section 5. Section 6 gives the relation between the collective obligation and individual ones by using the previous notions. We finish with some conclusions.

2 Collective obligations

Although obligations most often are aimed at individuals, like in the statutes of law, obligations can also be aimed at a group. (since there are cases in which the 'addressee' is not a single agent, but a group). It is important in this context not to confuse an collective obligation for a group with a restricted general obligation. A restricted general obligation indicates that for every person in a group the obligation holds. E.g.:

> Cyclists have to give way to motorvehicles

That a restricted generalized obligation is different from a collective obligation can be seen easily from the following example, taken from Rescher ([19]):

> 'John and Paul are obliged that the table is moved across the room.'

If John alone accomplishes that the table is moved across the room, then the group (John and Paul) satisfies the norm, i.e., the obligation that the table is moved across the room. It does not follow from the obligation that Paul would have to help John. This example expresses that from a collective obligation no obligation for the members of the group follow automatically. For example 'John is obliged that the table is moved across the room' does not follow. Thus, the obligation does not require that everyone (in this case, John and Paul) in the group takes part in the act to accomplish the obligation. For instance, a mother may tell her sons:

> 'Boys, the table has to be set.'

This command is given to a group of boys, and it requires that the group accomplishes something (i.e., that the table is set). We express this collective obligation in deontic logic[1] as follows: $O_X(p)$, where 'X' refers to the set of 'boys', and 'p' to the statement 'the table is set'. In general, $O_X(p)$ can be read as 'it is obligatory for X that p'. 'X' is used for the expression of a *collective agent* or group. Again, collective obligation $O_X(p)$ does not mean that this is a restricted general obligation, i.e., that for every agent in X it is obligatory that p, but that X *as a group* has to accomplish that p.[2]

If we want emphatically express that i and j both are 'essential' group-components to fulfill the obligation $O(p)$, then we can formalise this as follows:

$$O_{\{i,j\}}(p) \wedge \neg O_{\{i\}}(p) \wedge \neg O_{\{j\}}(p) \tag{1}$$

[1]Deontic logic is a branch of philosophical logic that is concerned with reasoning about norms, or in other words, about normative versus non-normative behaviour. It is the logic of obligations, prohibitions and permissions. As such, it is relevant for the foundations of ethics and law. Deontic logic has been used to analyse the structure of normative law and normative reasoning in law. However, as so many subjects in philosophical logic and philosophy in general, the subject was also picked up by computer scientists and AI (artificial intelligence) researchers. Deontic logic promises to be relevant as well for such prosaic matters as authorization mechanisms, decision support systems, database security rules, fault-tolerant software and database integrity constraints; thus, outside the area of legal analysis and legal automation. Deontic logic forms the basis of several legal expert systems. A survey of applications can be found in [16].

[2]For the semantics of the collective obligation we refer to [20].

We can regard (1) as a definition of genuine group obligation or *cooperative obligation* (cf. [10]).

In our interpretation of $O_X(p)$, we consider the groups to be separate 'agents' as in the theory of relativised deontic modalities concerning norms for an individual (e.g. [8, 9, 10, 13]), since now every group stands on its own, like agents. Such a group will be considered as a communicative, cooperative and coordinated group. A consequence of this interpretation is that we do not gain an understanding of the collectivity of the obligation concerning the relation amongst the individuals and the relation between the individuals (or subgroups) and their collective obligation to accomplish some goal. For that purpose we will introduce the notion of commitment.

3 Commitment

Intuitively, the relation between the members of the group and their collective oblligation is shaped by the commitment of the group to fulfill the obligation according to some plan and structure of the group. In this section we discuss some notions of commitment (as a descriptive ontology) which are crucial for the understanding of the relation between the individual agents and their collective obligation to accomplish some goal. Castelfranchi claimed in [1] that a notion of commitment is needed as a mediation between the individuals and the collective one:

> "Commitment" is seen as the glue of the group, of collective activity: it links the agent with the joint goal and the common solution, it links the members' actions with the collective plan, it links the members with each other.

¿From the above description of commitment, we infer three notions we will use for the analysis of the collective obligation:

1. joint goal;
2. collective plan;
3. delegation.

Before we will discuss these three notions, it is necessary to have a better understanding of commitment.

Suppose that you and I agree that I will make dinner and you will do the dishes. Each of us then has an obligation to conform to the agreement, at least in the absence of countervailing factors. What kind are the obligations of agreement? The distinction we make is between *obligations of joint commitment* and other kind of so-called obligation. We distinguish four kinds of commitment: personal commitment, social commitment, joint commitment and collective commitment. Before explaining what social and collective commitment is, it will be useful to characterize what we shall call 'personal commitment'.

3.1 Personal commitment

An agent is subject to a personal commitment if and only if the agent is the sole author of a commitment, and has the authority unilaterally to rescind it (cf. [7]). According to Cohen and Levesque ([14]) a personal commitment refers to a relation between an agent and an action. The agent has decided to do something, the agent is determined to do an action (at the scheluded time), the goal (itention) is a persistent one. The way to capture such a persistence is to establish that the intention is abandoned only if and when the agent believes that the goal has been reached, or that it is ompossible to achieve, or that it is no longer motivated. So, the agent can rid himself of it, only by changing his mind: the agent *has the authority* unilaterally to rescind his own decision.

Further, we assume that to commit to an action necessarily implies committing to some result of that action. Conversely, to commit to a goal always implies the commitment of at least one action that produces such a goal as result. Thus, we consider the action/goal pair $\tau = (\alpha, g)$ as the real object of commitment, and we will call it 'task'. Then by means of τ, we will refer to the action α, to its resulting goal g, or to both.

We prefer the term 'internal commitment' instead of 'personal (or individual) commitment', because we may attribute 'internal commitment' also to a group. A personal commitment suggests that it is just the internal commitment of one individual agent.

Many of the goals one might have, require the participation of two or more people for their achievement. Consider a simple transaction: If an agent wants to buy something, for instance, he will require the help of someone who sells it. Therefore, we need the notion of social commitment.

3.2 Social commitment

A social commitment is a commitment between two agents: the commitment of one agent to another (cf. singh91).[3] The social commitment cannot be composed of two internal commitments of two agents, it is created by two agents together. It expressess a relation between two agents, more precisely, social commitment is a 3-argument relation:

$$\text{S-Comm}(i, j, \tau),$$

where $i, j \in A$ with A a finite set of agents, and $\tau = (\alpha, g)$, meaning that i (the committed agent) is committed to j (the agent to whom i is committed) to achieve τ. In this case, only agent j is in the position (has the authority unilaterally) to rescind it. Thus, agent j can rely on the persistence of agent i's commitment to achieve τ.

A necessary condition of a social commitment is the mutual knowledge by the two agents about the commitment: there must be an agreement. In daily life, this is done by expressions in conditions of common knowledge (if it is 'out in the open') as far as the two

[3] In [1], the social commitment is considered as a relation between two or three agents. The third agent is the *witness*, who has a very crucial role in normative contexts (norms efficacy) (cf. [3]) and in contractual contexts implying als free riders and cheaters. For convenience, we will not discuss the third agent and therefore we will omit this from the paper.

agents are concerned (cf. [6]), and not, for instance, by a contract. Castefranchi (1995) shows that this condition is not sufficient. Two other conditions must be added:

1. The intention of agent i to achieve τ is a goal of agent j. Formally this can be expressed as

$$\text{S-Comm}(i, j, \tau) \rightarrow \text{Goal}_j(\text{Does}_i(\tau)). \tag{2}$$

2. Agent j is entitled (controlling, exacting, protesting) by agent i to τ.

According to Castelfranchi, a social commitment implies an obligation:

$$\text{S-Comm}(i, j, \tau) \rightarrow O_i(\tau). \tag{3}$$

The mistake of confusing commitment with obligation arises directly out of a conflation of the two distinct senses of the term commitment: the formula S-Comm(i, j, τ) only involves (unambiguously) the intensional sense of commitment (agent i *undertakes* an obligation to achieve τ from j), and the formula $O_i(\tau)$ the extensional sense of commitment (agent i has an obligation to achieve τ). So, in fact, S-Comm(i, j, τ) need not imply $O_i(\tau)$; we can undertake obligations that we do not have (cf. [23]). Therefore, we think that (3) is too strong. A social commitment can not imply a juridicial norm, but utmost a *directed* norm (which we will use):

$$\text{S-Comm}(i, j, \tau) \rightarrow O_i^j(\tau). \tag{4}$$

The directed obligation $O_i^j(\tau)$ is read as 'agent i (the addressee) has an obligation towards j (the counterparty) that τ will be achieved. Several authors ([9, 12, 15]) analysed or described the types of rights relationships between the addressees (or bearers) and counterparties from the classic work by Hohfeld ([11]). The counterparty is an agent or a group of agents that has a 'right' against the addressee, who has a 'duty' (an obligation). 'Right' and 'duty' are correlative terms, i.e. when a right is invaded, a duty is violated.[4] An example of a directed obligation is that John is obliged towards Paul that he shall stay away from Paul's land. In other words, Paul has a *right* against John that the latter will stay away from Paul's land, the correlative (and equivalent) being that John is under a *duty* toward Paul to stay away from the place. If John violates his duty under the directed obligation (or social commitment), he *ipso facto* fails to respect Paul's corresponding right.

3.3 Joint commitment

Just like the social commitment, the joint commitment is a commitment between two agents. But now, both agents are not in the position to rescind unilaterally their commitment, since the joint commitment is created by the two agents together. Each one is social

[4] In law, the word 'right' is often used to designate '*legal power*', '*legal claim*', and '*immunity* granted by an authority'.

committed through the joint commitment. In particular, it can be composed of two social commitments. Formally,

$$\text{J-Comm}(i, j, \tau_i \& \tau_j) := \text{S-Comm}(i, j, \tau_i) \wedge \text{S-Comm}(j, i, \tau_j), \tag{5}$$

where τ_i and τ_j are the tasks agent i, respectively, agent j are committed to achieve. The joint commitment as we defined here is, in contrast with the social commitment, a symmetrical relation.

In general, two agents are jointly committed, they are jointly committed to doing something as a body (as a single unit). As a body they commit to achieve $\tau_i \& \tau_j$ under the agreement that agent i is committed to achieve τ_i and agent j is committed to achieve τ_j. An agent actually has the authority to rescind unilaterally the social commitment of the other agent, however he cannot rescind unilaterally the joint commitment. To rescind the joint commitment, the two agents must rescind it together. In everyday life, joint commitments are frequent. For instance, when a married couple makes the agreement that the man will make the diner and the wife will do the dishes. They are jointly committed by mutually accepting a certain goal as a body.

¿From the two formulae (2) and (5), it follows that

$$\text{J-Comm}(i, j, \tau_i \& \tau_j) \rightarrow \text{Goal}_j(\text{Does}_i(\tau_i)) \wedge \text{Goal}_i(\text{Does}_j(\tau_j)). \tag{6}$$

3.4 Collective commitment

The collective commitment is defined as the internal commitment of a group (a collective agent) X given a collective plan and an authority-relation concerning the structure of group X. So we represent the collective commitment as a conditional one:

$$\text{C-Comm}(X, \tau | \text{Plan}, \text{Auth(X)}), \tag{7}$$

meaning that the group X has a collective commitment to achieve p given a collective plan P and an authority-relation, which indicates the structure of the group. The collective plan and the authority relation we discuss in the next section. So, a set of agents is internally committed to a certain intention under the condition that there is a mutual knowledge between the agents about that according a plan and an authority-relation. In the following sections we try to clarify the relationships between the social and joint commitment, and the collective one. This will help us to indicate who has the authority to rescind unilatterally some particular commitments in the collective one and who has the responsibility to a certain subtask. This also depends on delegation, which is the core of the social commitment relationship (cf. [2]).

A collective commitment presupposes an associated collective intention with respect to the goal and a common belief in the whole group that the plan is adopted by the committed members of the group. In this paper the characterisation of the collective commitment is not studied, but the interested readers we refer to [4].

4 Delegation and authority-hierarchy

Informally, in delegation an agent i needs or likes an action of another agent j and includes it in its own plan, i is trying to achieve some of its goals through j's actions; thus i has the goal that j performs a given action. In our model, delegation is characterized in terms of the particular set of mental states (cognitive ingredients) of the agents involved in the interaction.

Delegation is generally a social action (cf. [3]), and also a meta-action, since its object is an action. We introduce an operator of delegation with three parameters:

$$\mathrm{Del}(i, j, \tau),$$

where $i, j \in A$ and $\tau = (\alpha, g)$, meaning that i delegates the task τ to j.

On the basis of the kind of interaction between the delegating agent (client) and the delegated one (contractor), Castelfracnchi ([2]) defines five basic types of delegation. In this paper, we are only interested in an interaction based on explicit agreement, on the active achievement by i of the task through an agreement with j, which we will call *contract*. In a contract, the delegated agent knows that the delegating agent is relying on it and accepts the task. If the agreement is settled, the delegated agent j is socially committed to the delegating agent i to achieve the agreed task τ for i. Formally,

$$\mathrm{Del}(i, j, \tau) \rightarrow \text{S-Comm}(i, j, \tau). \tag{8}$$

With (3), we can derive then

$$\mathrm{Del}(i, j, \tau) \rightarrow O_i^j(\tau). \tag{9}$$

An important dimension of a contract concerns how the task is specified in the delegation action; how this specification influences the contractor's autonomy, how different interpretations of the specification of the ask for client and contractor could produce misunderstanding and conflicts. For our purpose, we only consider a completely specified (or close) delegation.[5] In a close contract the delegating agent i and delegated agent j collaborate in a plan that they share and know fully, in which the task is completely specified. In such a contract also the actions are completely specified how to achieve the task that i expects from j.

We will say that j subdelegates the task τ if there at least two other agents ($i, k \in A$) such that

$$\mathrm{Del}(i, j, \tau) \wedge \mathrm{Del}(j, k, \tau), \tag{10}$$

[5]However, minimally specified (or open) delegation is fundamental, because it is also due to the delegated agents's ignorance about the world and its dynamics. In fact, frequently enough it is not possible or convenient to fully specify the task because some local and updated knowledge is needed in order for the part of the plan to be succesfully executed.

where i, j and k are different agents. Agent i is delegated to task τ but by means of whom/what it will achieve τ is not defined. In strict delegation, the responsibility of the achievement of τ without fixing the performer(s) of the action(s) is fixed to j. For example, the chairman of the program committee delegates a member j to review some of the submitted papers. For lack of time, member j subdelegates the task to his assistent. The responsibility of the achievement to review these submitted papers still stays with the member, and will not be transferred to the assistent. From this, it follows that delegation, as we defined, is not a transitive relation (thus $\mathrm{Del}(i,j) \wedge \mathrm{Del}(j,k)$ does not imply $\mathrm{Del}(i,k)$) and obviously not symmetrical.

The authority-relation concerns the structure of the group X. The formula $auth(i,j)$ indicated that agent i can delegate a certain subtask to agent j. The above member of the program committee can delegate his task to review some papers to his assistent, since he has some authority to delegate his task to his assistent. The same holds for the relation between the chairman of the program committee and this member. Usually the authority-relation is reflected in organigrams of companies or groups. The authority-relation is - just like delegation - not symmetrical, and not transitive. We will represent the authority-relation of the group by $\mathrm{Auth}(X)$:

$$\mathrm{Auth}(X) := \{auth(i_l, i'_l) | i_l, i'_l \in X\}, \tag{11}$$

meaning that $\mathrm{Auth}(X)$ is the set of all existing authority-relations between two agents and in the group X. The relation between authority and delegation is given as follows:

$$\mathrm{Del}(i_l, i'_l, \tau) \rightarrow auth(i_l, i'_l), \tag{12}$$

meaning that an agent i must have some authority over agent j if he wants to delegate a task. So, authority is a necessary condition for delegation.

5 Collective plan

To fulfil a collective obligation $O_X(p)$, the group X has to decompose the task τ (to achieve τ) into a number of individual subtasks. For example, if the program committee is obliged to notify the authors of the submitted papers of acceptance before a certain deadline, this obligation can only be fulfilled if the work that has to be done, is shared out in several tasks over the members of the program committee. Therefore, the group needs a plan: a concrete manner to achieve the task of the group. A plan includes *task division* and *task allocation* (see [4]). Task division is the decomposition of a complex task τ into subtasks $\tau_1, \ldots, \tau_n$. Task allocation indicates which agent of the group has to achieve which subtask of the complex task. This results in a sequence of individual subtasks that realizes the complex task (the collective goal). We represent a plan as

$$\mathrm{Plan}(< i_1 : \tau_1, \ldots, i_n : \tau_n >, \tau, X),$$

with

- $< i_1 : \tau_1, \ldots, i_n : \tau_n >$ the sequence of individual subtasks $i_l : \tau_{i_l}$ $(1 \leq l \leq n)$,
- τ the collective task, thus $\tau_1 \wedge \ldots \wedge \tau_n \rightarrow \tau$ and
- X the collective group and $i_l \in X$ for all $l \in \{1, \ldots, n\}$.

A plan determines the individual subtasks, but we did not account yet for the fact that some goals might depend on other ones. So, a plan must also determine the *order* of subtasks: the temporal structure of the individual subtasks. For example, the notification of acceptance of a certain paper can only be done if it is reviewed by the delegated members of the program committee. Thus, an individual obligation can sometimes only be fulfilled if other obligations are already fulfilled. I.e., the responsibility of an individual obligation $O_{i_l}(\tau_l)$ depends not only on the individual who is committed to fulfil the obligation, but also on agents who have to achieve subtasks which are necessary to fulfil the individual obligation $O_{i_l}(\tau_l)$. This means that a plan does not only contain a set of individual subtasks, but also contains an order of the individual subtasks, i.e., a sequential composition of the individual subtasks.[6] A sequential composition of individual subtasks $i_1 : \tau_1$ and $i_2 : \tau_2$ can be denoted by $i_1 : \tau_1; i_2 : \tau_2$: the subtask τ_2 has to be achieved after subtask τ_1. So the obligation of agent i_2 is conditional: Suppose agent i_2 is responsible for the fulfilment of the obligation to achieve goal τ_2, then we will express this individual obligation as a conditional one, since the obligation will come into force if τ_1 is achieved: $\tau_1 \rightarrow O_{i_2}(\tau_2)$. So, if agent i_1 violates his obligation to achieve τ_1, agent i_2 (who cannot fulfill his obligation) is not responsible for the violation of his obligations, since he has a 'right' to hold agent i_1 responsible for this violation, because of the fact that agent i_1 violates his own duty. For convenience, we will leave out the sequential compositions, since it obscures the point we want make in this paper.

Since, for convenience, we only consider contracts (with explicit agreements), the plan is fixed (a *close* plan). So, every subtask with his performer is fixed, which in fact is counter-intuitive for organizations, since it ignores the dynamic world with e.g. updated information.

6 The relation between collective and individual obligation

Now that we have introduced the notions of collective commitment, plan and group structure (by delegation and authority-relation), we are able to represent the relation between the collective obligation and the individual directed obligations (following from the collective oobligation):

$O_X(\tau) \wedge \text{C-Comm}(X, \tau | \text{Plan}, \text{Auth}(X)) \wedge \text{Plan}(< i_1 : \tau_1, \ldots, i_n : \tau_n >, \tau, X) \wedge \text{Auth}(X) \rightarrow$

[6] Furthermore, we can imagine that some individual tasks has to be achieved simultaneously, which can be denoted as $i_1 : \tau_1 \& i_2 : \tau_2$.

$$O_{i_1}^{i'_1}(\tau_1) \wedge \ldots \wedge O_{i_n}^{i'_n}(\tau_n). \tag{13}$$

Thus, if there is a collective obligation and a way to achieve τ for group X consisting of a fixed plan and a group structure $\mathrm{Auth}(X)$, and there is a collective commitment to follow that plan and observed by the authority-relation while pursuing the task τ, then there is a directed obligation for each agent i of the group X to achieve his subtask τ_i. The directed obligation is directed towards the member i' of the group X by delegation according to the authority-relation. Note that the individual directed obligation is an internal obligation, and that only the collective obligation is an external obligation of the group.

The directed obligations that follow from the collective obliggation in the way described in above formula (16) will easily exhibit normative coherence, which is a property desired for collective actions. Normative coherence between the agents of group X can be formalised as:

$$\forall_{l\in\{1,\ldots,n\}}(O_{i_l}^{i'_l}(\tau_l) \rightarrow \forall_l \forall_k(\neg O_k^j(\neg\tau_l))), \tag{14}$$

meaning that as soon as agent i_l is obligated towards i'_l to achieve τ, normative coherence makes it necessary that for all agents of the group X it holds that they are not obligated to achieve $\neg\tau$ (towards any agent j of the group). This normative coherence actually follows from the fact that the plan should be well devised, i.e., different parts of the plan should not obstruct each other to achieve the collective task.

The last point that we want to mention concerns about the interdefinability between $O(p)$ and $F(p)$. Since if we accept the implication following from the above formule we have to give up the interdefinability principle of the standard deontic logic for the prohibition:

$$O(p) := F(\neg p). \tag{15}$$

The above relation seems to be natural and intuitively correct, and thus not depending on any (formal) property of the O-operator itself. We would expect therefore that if principle (15) holds, we could apply it to relation (16). However, if we do that, we get the following formula:

$$F_X(\neg\tau) \wedge \text{C-Comm}(X, \tau|\mathrm{Plan}, \mathrm{Auth}(X)) \wedge \mathrm{Plan}(< i_1 : \tau_1, \ldots, i_n : \tau_n >, \tau, X) \wedge \mathrm{Auth}(X) \rightarrow$$

$$F_{i_1}^{i'_1}(\neg\tau_1) \wedge \ldots \wedge F_{i_n}^{i'_n}(\neg\tau_n). \tag{16}$$

which is highly counter-intuitive. Although, in this paper there is not enough room to explore this in full depth. Our hypothesis is that the problems stem from the fact that both group structure and plan structure are defined outside the scope of the deontic operator and therefore not influenced by the negation of principle (15). Otherwise, this problem calls for changes of respective deontic systems (which are too rigid) with respect to principle (15).

7 Conclusions

First of all, there are more complex and more interesting questions in the logical theory of collective obligation:

> From the point of view of methodological individualism, the action of a collective is in some sense composed of or determined by individual actions performed by the members of the collective. The general study of the nature of that composition, of the dependence of collective actions on individual ones, could be said to constitute the theory of collective action in a narrower sense. ([17])

A first attempt is made to 'constitute the theory of collective action in a narrower sense' by the introduction of commitment and to define an goal of a collective as a sequence of individual subtasks. The notion of commitment is very useful to determine which *plan* will be followed to fulfill a collective obligation (collective commitment) and to determine which agent has to perform (or is responsible to perform) a certain subtask - being part of the committed sequence - to achieve the joint goal (individual commitment). To indicate the responsibility of the individual agents to achieve their subtasks, we need the notion of commitment. As we already said, the fulfillment of a collective obligation can only be reached if the group decomposes their goal into a number of individual subtasks by *commitment*. We cannot appropriately influence these individual obligations if we do not exactly know the individual commitments of the group.

We have shown how the relation can be made between the collective obligation and the individual directed obligations, through the use of group structure (by delegation and authority-relation), collective plan and collective commitment towards that plan. We have indicated that normative coherence is a natural consequence of this relation.

We have seen that the properties of collective obligation (as indicated in relation (16) do not allow the interdefinability of the collective obligation with the collective prohibition as defined in most deontic logics.

Finally, we note that 'right' and 'duty' play a role in the combination of collective obligation and commitment. This and other subjects, such as open delegation and maintenance of commitment are issues for future research. We gave a first step to realise the formalisation of the individual responsibility of a collective obligation.

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