We translated the terms here for consistency with the study report. Next, we explain its components (about the improved version) and present the rules we created based on the hospital bed management context. Our ontology is composed by 15 main classes, with 80 related sub-classes, containing 95 classes total. Note that all the concepts described here refer to the scenario created by the researchers, and they can have different meanings in different contexts.

Attendance: The term *attendance* is used to refer to the whole period the patient attended any activity in a hospital, either ambulatorial or hospitalisation. *Ambulatorial* is the assistance that occurs via prior scheduling or by emergency need. It has *Elective* (when it is scheduled) and *Emergency* sub-classes (when it occurs without scheduling, because of an urgent need of the patient). *Hospitalisation* occurs when the patient needs to stay in hospital for more than one day, occupying a Hospital_Bed.

Risk_Classification: A risk category assigned to patients when they start being cared for, widely used in the emergency sector to prioritise patients in worst health conditions. We describe it based on Manchester protocol, defined by Mackway-Jones, Marsden, and Windle [**?**]. Sub-classes range from immediate to non urgent. A patient that has risk of death is classified as *Very_ urgent*. Patients with immediate risk of limb loss or loss of organ function are classified as *Very_ urgent*. Patients with conditions that can worsen if not helped soon are *Urgent*. Patients with low risk of health damage are *Standard*, and the ones without any immediate risk of health damage are *Non_ urgent*.

Temporal_concept: Concepts related to the timing of events. It includes the following sub-classes: Now, Year, Date, Day, Today, Hour, Time interval, Month, and Week.

Document: It refers to the documents generated during or after a patient's attendance. It includes diagnosis, report, prescription, and medical records. (1) *Diagnosis*: made by a doctor, it determines the disease nature and cause, based on the patient history, symptoms, examination, etc. (2) *Report*: made by a specialist doctor, it usually contains the analysis of exams, such as radiology, laboratory, etc. (3) *Prescription*: made by a doctor, it includes drugs and treatments recommended to the patient. 4) *Medical_ records*: it includes all the data related to the patient that can be accessed and stored by the hospital.

Disease: Biological alteration of a person's health state, manifested by a set of symptoms.

Speciality: Represents the medical specialisation or expertise that the doctor possesses or that the patient needs.

State: it represents patient conditions, and has 5 sub-classes: Coma, In treatment, Stable, Severe, and Vegetative.

Situation: it represents hospital bed conditions, and has 5 sub-classes: Blocked, Clean, Free, Occupied, and Dirty.

Local: places inside a hospital. Sub-classes are: Corridor, Pharmacy, Bed, Room, Reception, and Hospitalisation_Unit. The hospitalisation_Unit also has sub-classes named: Speciality_Unit, Nursery, Pediatrics, Intensive_Care Unit, and Special_Care_Unit.

Medication: the drugs stored on the Pharmacy, which are meant to treat the patients.

Furniture: All the furniture that belongs to the hospital. For this study, we describe just two sub-classes: Bed and Stretcher.

Person: People who belong to the hospital ecosystem. Sub-classes are: *Companion, Man, Woman, Patient,* and *Employee*. Employee has the following sub-classes: *Administration, Cleaner, Receptionist, Security_Guard, and Health_Professional*. The last one comprehends *Nurse, Nursing_Technician,* and *Doctor*. *Doctor* also have sub-classes named: *Generalist, Resident,* and *Specialist*. *Specialist* has the following sub-classes: *Cardiologist, Dermatologist, Neurologist, Oncologist, Pediatrician, Pneumologist, Radiologist, and Traumatologist*.

Restriction: rules to restrict bed allocation. (1) *Routing*: Origin of the patient, for example if he came from the emergency or is an elective patient. (2) *Age*: person's age group, which can be adult, teenager, or child. (3) *Gender*: male or female. (4) *Isolation*: Refers to the cases where the patient cannot be in the a room with other patients. (5) *Puerperal*: Women who just gave birth. (6) *Length_Of_Stay*: Predicted time of patient stay in the hospital, can be turn-fast or long-stay. (7) *Hospital_Care*: Hospital care the patient needs, can be surgical or clinical. (8) *Type_Of_Care*: Type of care that the patient needs, can be minimal, semi-intensive or intensive.

Symptom: Signs to which the patient refers when talking about his illness (pain, fever, etc.).

Treatment: Set of instructions of procedures that the doctor recommends for the patient undergo.

We created also 89 relationships between the classes, and we present it in Table 1. We have not included all possible relationships between classes, only those we consider interesting for this domain, so we could see clearly how the classes relate to each other, to help us test the rules.

We instantiated 81 individuals, so we could use the reasoner to test our rules. Individuals we created include Patient, Room, Hospital_Bed, Symptoms, and so on. To create them, we used names such as Patient1, 100, 100A, Headache, and so forth.

Our ontology aims to help decision making about the beds where patients can be allocated according to the bed allocation constraints. Thus, we establish rules that propagate information about registered individuals' restrictions, and we can use these rules to ontological reasoning with Pellet reasoner. We are aware that many rules can be created to help decision making related to bed allocation in hospitals. We present the ones we created for our ontology in Table 2.

Table 1 – Bed allocation ontology object properties

Domain	Object Property	Range	Inverse of
Companion	accompanies	Patient	is-accompanied-by
Attendance	happens-in	Temporal_concept	
Nurse	allocates	Hospital_Bed	is-allocated-by
Health_Professional	analyses	Document	is-analysed-by
Patient	presents	Symptom	is-presented-by
Patient	presents-one	Disease	
Employee	attend	Patient	is-attended-by
Health_Professional	evaluates	Patient	is-evaluated-by
Patient	consumes	Medication	is-consumed-by
Patient	have-appointment	Doctor	
Patient	needs-assistance-like	Attendance	
Doctor	discharges	Patient	is-discharged-from
Patient	vacates-one	Hospital_Bed	is-vacated-by
Doctor	diagnoses-one	Patient	is-diagnosed-by
Attendance	is-associated-to	Risk rating	
State	is-assigned-to	Patient	
Disease	is-characterised-by	Symptom	
Hospitalisation	is-made-in-one	Hospital_Bed	
Patient	is-medicated-by	Nursing_Technician	
Patient	is-moved by	Health_Professional	
Patient	is-observed-by	Health_Professional	
Patient	is-classified-as	Risk_Classification	
Doctor	is-responsible-by	Patient	
Hospital_Bed	is-in	bedroom	
Hospital_Bed	is-suitable-for	Patient	
Hospital_Bed	is-unsuitable-for	Patient	
Furniture	is-in-a	Local	
Bedroom	is-in-one	Hospitalisation_Unit	
Pharmacy	make-dispensation-of	Medication	
Radiologist	make-report-of	Image_Exam	is-reported-by
Patient	makes-one	Exam_Type	
Janitor	sanitises-one	Local	is-sanitised-by
Doctor	indicates-one	Treatment	
Patient	occupy-one	Hospital_Bed	is-occupied-for
Hospital_Bed	may-have	Restriction	
Hospital_Bed	own-one	State	
Employee	fill-one	Document	is-filled-by
Doctor	prescribes	Medication	is-prescribed-by
Image_Equipment	performs	Image_Exam	is-performed-on
Patient	has-one-attendance	Attendance	
Hospital_Bed	has-a	Bed	
Symptom	characterises-a	Disease	is-characterised-by
Patient	is-diagnosed-by-one	Doctor	

Table 2 – Rules of the bed allocation ontology

	Rules
1.	$\{Patient(?X), Man(?X) \rightarrow is-of-the-gender(?X, Male)\}$
2.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-isolation(?Y, ?I) \rightarrow bedroom-is-isolation(?Z, ?I)\}$
3.	$\{Patient(?X), has-one-attendance(?X, ?A) \rightarrow is-routing(?X, ?A)\}$
4.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-the-attendance(?Z, ?A) \rightarrow bed-is-the-attendance(?Y, ?A)\}$
5.	$\{Patient(?X), is-routing(?X, ?E), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-routing(?Y, ?E)\}$
6.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-stay(?Y, ?P) \rightarrow bedroom-is-stay(?Z, ?P)\}$
7.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-puerperal(?Y, ?Q) \rightarrow bedroom-is-puerperal(?Z, ?Q)\}$
8.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-speciality(?Z, ?S) \rightarrow bed-is-speciality(?Y, ?S)\}$
9.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-speciality(?Y, ?S) \rightarrow bedroom-is-speciality(?Z, ?S)\}$
10.	$\{Patient(?X), Woman(?X) \rightarrow is-of-the-gender(?X, Female)\}$
11.	$\{Patient(?X), is-care(?X, ?C), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-care(?Y, ?C)\}$
12.	$\{Patient(?X), is-puerperal(?X, ?Q), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-puerperal(?Y, ?Q)\}$
13.	$\{Patient(?X), is-the-attendance(?X, ?A), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-the-attendance(?Y, ?A)\}$
14.	$\{Patient(?X), is-stay(?X, ?P), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-stay(?Y, ?P)\}$
15.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-routing(?Y, ?E) \rightarrow bedroom-is-routing(?Z, ?E)\}$
16.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-of-the-age-group(?Y, ?G) \rightarrow bedroom-is-of-the-age-group(?Z, ?G)\}$
17.	$\{Patient(?X), is-classified-as(?X, Urgent) \rightarrow needs-assistance-like(?X, Hospitalisation)\}$
18.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-of-the-age-group(?Z, ?G) \rightarrow bed-is-of-the-age-group(?Y, ?G)\}$
19.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-of-the-gender(?Z, ?H) \rightarrow bed-is-of-the-gender(?Y, ?H)\}$
20.	$\{Patient(?X), is-isolation(?X, ?I), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-isolation(?Y, ?I)\}$
21.	$\{Patient(?X), is-speciality(?X, ?S), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-speciality(?Y, ?S)\}$
22.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-routing(?Z, ?E) \rightarrow bed-is-routing(?Y, ?E)\}$
23.	$\{Patient(?X), is-of-the-gender(?X, ?H), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-of-the-gender(?Y, ?H)\}$
24.	$\{Patient(?X), is-of-the-age-group(?X, ?G), Hospital\_Bed(?Y), occupy-one(?X, ?Y) \rightarrow bed-is-of-the-age-group(?Y, ?G)\}$
25.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-the-attendance(?Y, ?A) \rightarrow bedroom-is-the-attendance(?Z, ?A)\}$
26.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-care(?Z, ?C) \rightarrow bed-is-care(?Y, ?C)\}$
27.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-isolation(?Z, ?I) \rightarrow bed-is-isolation(?Y, ?I)\}$
28.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-puerperal(?Z, ?Q) \rightarrow bed-is-puerperal(?Y, ?Q)\}$
29.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-of-the-gender(?Y, ?H) \rightarrow bedroom-is-of-the-gender(?Z, ?H)\}$
30.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bedroom-is-stay(?Z, ?P) \rightarrow bed-is-stay(?Y, ?P)\}$
31.	$\{Hospital\_Bed(?Y), Bedroom(?Z), is-in(?Y, ?Z), bed-is-care(?Y, ?C) \rightarrow bedroom-is-care(?Z, ?C)\}$
32.	$\{Patient(?X), is-years-old(?X, ?Y), lessThan(?Y, 12) \rightarrow is-of-the-age-group(?X, Child)\}$
33.	$\{Patient(?X), Hospital\_Bed(?Y), is-of-the-gender(?X, ?Gp), bed-is-of-the-gender(?Y, ?Gb), DifferentFrom(?Gp, ?Gb) \rightarrow is-unsuitable-for(?Y, ?X)\}$
34.	$\{Patient(?X), is-discharged-from(?X, ?Y), occupy-one(?X, ?Z) \rightarrow vacates-one(?X, ?Z), is-vacated-by(?Z, ?X)\}$
35.	$\{Patient(?X), Hospital\_Bed(?Y), is-speciality(?X, ?Sp), bed-is-speciality(?Y, ?Sb), DifferentFrom(?Sp, ?Sb) \rightarrow is-unsuitable-for(?Y, ?X)\}$
36.	$\{Patient(?X), is-years-old(?X, ?A), greaterThan(?A, 17) \rightarrow is-of-the-age-group(?X, Adult)\}$
37.	$\{Patient(?X), Hospital\_Bed(?Y), is-of-the-age-group(?X, ?Ap), bed-is-of-the-age-group(?Y, ?Ab), DifferentFrom(?Ap, ?Ab) \rightarrow is-unsuitable-for(?Y, ?X)\}$
38.	$\{Patient(?X), Hospital\_Bed(?Y), is-of-the-gender(?X, ?G), bed-is-of-the-gender(?Y, ?G), is-of-the-age-group(?X, ?A), bed-is-of-the-age-group(?Y, ?A), is-speciality(?X, ?S), bed-is-speciality(?Y, ?S), is-care(?X, ?C), bed-is-care(?Y, ?C) \rightarrow is-suitable-for(?Y, ?X)\}$
39.	$\{Patient(?X), is-years-old(?X, ?A), greaterThan(?A, 11), lessThan(?A, 18) \rightarrow is-of-the-age-group(?X, Teenager)\}$
40.	$\{Patient(?X), Hospital\_Bed(?Y), is-care(?X, ?Cp), bed-is-care(?Y, ?Cl), DifferentFrom(?Cp, ?Cl) \rightarrow is-unsuitable-for(?Y, ?X)\}$