WP6
System security and data management

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WP6_Objective

The main objective of this work package is to **evaluate and analyse the risk** connected with the information coming from the vision systems in order to manage the plant in **safe conditions** and guarantee a **correct operability** of the intermodal terminal

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WP6_Objective

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WP6_Contents

- All the possible **failure events** of the vision systems have been **analysed** and **classified**
- A set of **recovery actions** have been **defined**
- A **stochastic simulation model** of the terminal has been built to **simulate** the **handling logic**, the **failures** of the various vision devices and the ensuing **repair actions**

WP6_Contents

- **Scenarios** which simulate both **standard** and **critical conditions** have been run to **ensure the plant safety** and to investigate the **effects of the failures** on the **final reliability level** and on the **terminal correct operability** in accordance with the targets and the constraints imposed by the SMEs.

WP6_Output

The final output of this WP are:

- A **report** which contains a classification of all the events/information/failures coming from the vision systems and a definition of the recovery actions for these events
- A **stochastic simulation model** of the terminal which simulates both the material handling processes and the vision system events
- The **numeric deliverables** of the simulation analysis which permit to compare different scenarios

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WP6_Classification of the failure events

- To collect data about the failure events of the vision systems, meetings with the owners of the other WPs and with the SME's have been organized and a .xls template has been developed

- The disturbances have been classified into categories at several levels leading to various actions when experienced during operations

- Failure events have been categorized according to their **type**, **frequency** and **importance**

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WP6_Failures type

- A failure has been classified as "***Time***" if it is a time-base failure; stochastic failures occur according to a given frequency distribution

- A failure has been classified as "***Count***" if it is a count-based failure; failure occurs after the resource has been released the number of time specified

- A failure has been classified as "***Percentage***" if it is a percentage-base failure; it is a particular "count" failure (ex. False positive and false negative)

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WP6_Failures Frequency

- A failure has been classified as "***Rare***" if its frequency is less the one per year
- A failure has been classified as "***Remarkable***" if its frequency is less the one per month, but more then one per year
- A failure has been classified as "***Frequent***" if its frequency is one per month at least
- A failure has been classified as "***Daily***" if its frequency is almost one per day

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WP6_Failures Importance

- An event is a "***Minor***" event if it causes a not remarkable degradation of the system performances with a negligible damage to the system
- An event is a "***Significant***" event if it causes a remarkable degradation of the system performances with an appreciable damage to the system
- An event is a "***Critical***" event if it could potentially cause loss of primary system functions resulting in significant damage to the system or dangerous situation for the human operators

WP6_The Simulation Model

- A **simulation model** of the terminal has been implemented by using Rockwell Arena 12.0 in order to **compare different scenarios** and to predict the final reliability level
- The simulation software has been implemented as a **discrete-event** simulation model
- A set of **plant safety** and **terminal operability KPIs** has been defined for the simulation model

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WP6_The Simulation Model

- The simulation model has been integrated with Microsoft Office for **input functionalities**: a specific **input data file** has been performed to introduce and **change** different **project parameters** easily, by using VBA routines

- The input data file (.xls) allows to feed the simulation module with a **possible configuration;** acting on this input data file the user can modify the terminal definition. In particular, the user can **modify the failures parameters** and he can run a new scenario.

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WP6_The Simulation Model

- The simulation model is an efficient tool to test and improve the container handling reliability and all the terminal operations. Simulation has been used to model all the vision systems implemented in the other WPs. The vision systems in the model can be affected by “disturbs”, based on stochastic events (where the parameters permit, for example, to simulate different weather conditions)
- In case of **anomalous conditions** the control logics **alert** operators or even **block** the plant. Alerts and blocks require operators procedures

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WP6_The Simulation Model

- The **terminal** has been modelled as a **set of platforms**, which are **served by** a number of **cranes** and automated transfer equipments (**shuttles and turrets**). The train arrivals and the patterns of trucks **arrivals** for ITU are **statistically modelled**

- During the simulation, various **statistics are gathered** to asses the performance of the terminal equipments (both of the automated transfer devices and of the vision systems), the train residence time, and the terminal throughput.

WP6_The Simulation Model

The final version of the model includes:

- Stochastic Containers Arrival Patterns (from trucks)
- Trains Arrival Patterns
- Containers Handling Logic (for loading/unloading operations)
- Failure logic for vision system and recovery actions
- Model Outputs (Terminal KPIs)

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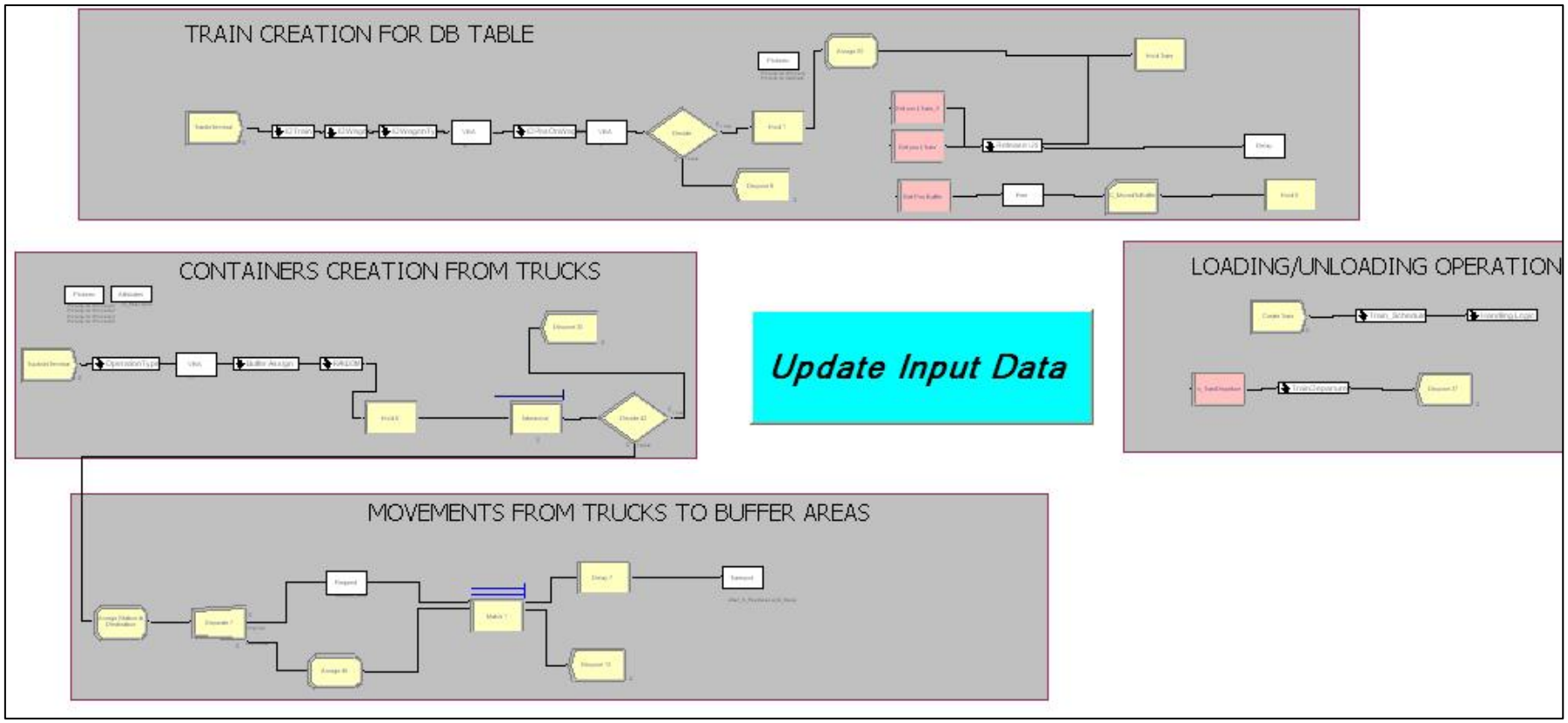
WP6_The Simulation Model



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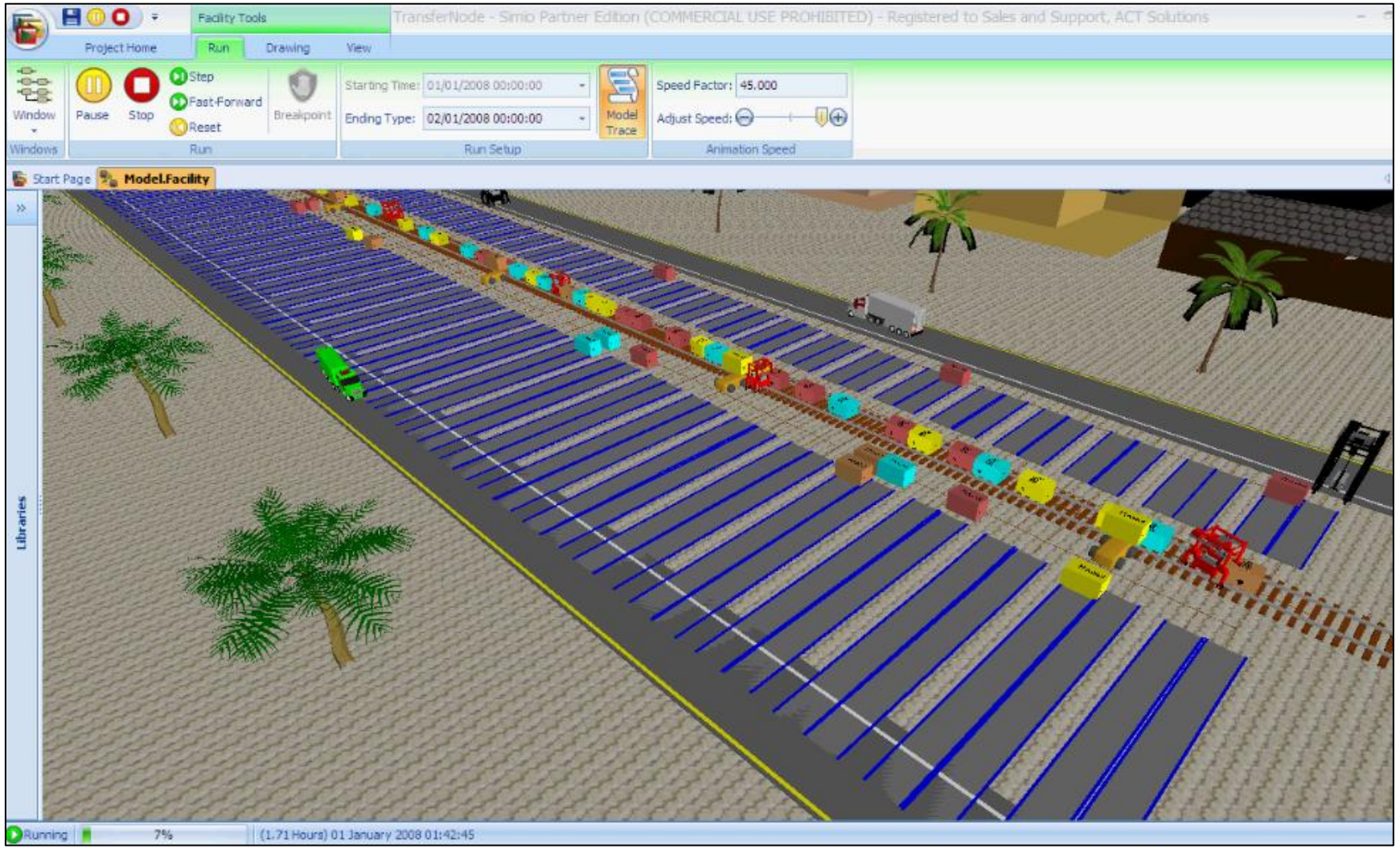
WP6_Animation of the terminal operations



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WP6_Run of scenarios

The **discrete stochastic simulator** of the terminal has been **integrated** with **failure mode effects** and **critical scenarios analysis** to establish the risk of catastrophic failures and to estimate the final reliability both for plant safety and for correct terminal operability.

WP6_Run of scenarios

- Outputs coming from **critical scenarios** have been analysed in order to understand the **real influence of perturbations on system security and terminal productivity** and they have been compared with the outputs coming from the standard scenario and with the desired service level

- The simulation model of the terminal has been fed by the SME's experts through the use of the input data excel file with a suitable configuration; the different scenarios refer to different "**FailureParameters**"

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WP6_Run of scenarios

The following scenarios have been run to evaluate the **standard** and the **maximum** resulting **risk** and to understand if it is acceptable by the SME's

- **"*Standard Scenario*"** with no failure events coming from the vision systems

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WP6_Run of scenarios

- **“*Standard Failure Scenario*”** with standard vision systems failures added. The frequency of the failure events has been changed according to the field tests. Only events with “daily” frequency have been modelled

- **“*Critical Weather Conditions Scenario*”** in which critical weather conditions have been simulated. The frequency of the failure events has been changed according to the field tests; only events with “daily” frequency have been modelled

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WP6_Run of scenarios

- **"*Maximum Failure Standard Scenario*"** with maximum error percentage in standard conditions added; only "daily" or "critical" events have been modelled

- **"*Maximum Failure Critical Weather Conditions Scenario*"** with maximum error percentage in critical weather conditions added; only "daily" or "critical" events have been modelled

WP6_Run of scenarios

- For each scenario 7 days have been simulated (replication length) and 10 simulation runs have been executed (number of replications)

The outputs coming from the analysed scenarios have been discussed by the SME's experts and they have been validated. When the field tests will be finished, other scenarios will be tested by using the simulation model

WP6_SafetyResults

The most frequent events are:

- A wrong recognition of the empty spaces on the train
- A false positive alert coming from cameras monitoring the terminal area

These events are **not critical**; they have **no risks for people security**, and they have not an important influence on system productivity.

WP6_SafetyResults

- The only **critical event for human safety** is a **false negative** event **from the work area cameras**; the simulation results report that it is a **very rare event in any condition**; in fact, both the terminal area and the work area cameras must fail to not detect a human presence in the loading area

- Besides, these **results** are **referred** to a **"*not constrained terminal*"** without any limited access point where common people can move freely around the terminal area.

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WP6_SafetyResults

Combining the ***physical constraints*** of the terminal and the ***results coming from the simulation*** of the WP5 cameras, it is possible to say that human safety is ensured because a ***human presence in the work area is a virtually impossible event***

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WP6_OperabilityResults

- Also in critical weather conditions the very strict temporal **constraint of 40 - 45 minutes** for trains' loading/unloading **is met**, considering a **tolerance of two minutes**

- The terminal utilization varies between 35% and 38% , that corresponds to 8-9 operating hours per day (with 12 arriving trains per day)

For the considerations above the correct terminal operability is ensured both in standard and in critical conditions

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Developments of the Simulation Model

- All the main features of a Metrocargo terminal have been implemented in the simulation model (equipments, buffer areas, vision systems, etc.)
- The discrete-event simulation tool based on the process-oriented paradigm provides a test bed for checking the validity and robustness of the suggested solutions.
- In the future developments the simulation model of the intermodal Metrocargo terminal may be integrated with a **planner** and a **scheduler** for **optimising all the terminal activities**

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