Evaluation of the Video Content Analysis applicability by risk level

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***Abstract*—** Main contribution of this research paper is the systemic implementation of the latest digital functions used by surveillance cameras such as digital signal processor (DSP) functions and several tools of video content analysis (VCA). Functions of the particular tools are described in detail and the qualitative analysis of them has been executed in order to extend current form of the EN 50 132 appendixes, where the specific monitored locations are defined. On the basis of qualitative assessment of these locations the particular tools are assigned to locations in order to increase the efficiency of the whole surveillance system. Moreover, the semi-quantitative evaluation of the Video content analysis is accomplished in order to provide exact specification and evaluation of particular Video content analysis tool for each model scene.

***Keywords*—** Video Surveillance System, DSP, Building blocks, Video Content Analysis, Implementation, Semi-quantitative evaluation of applicability

I. Introduction

The rules and guidance related to the VSS are defined by the set of European Standards EN 50 132 that are assembled by European Committee for Electrotechnical Standardization (CENELEC) in collaboration with two non-profit organizations, Open Network Video Interface Forum (ONVIF) and Physical Security Interoperability Alliance (PSIA), which were created by leading corporations on the VSS market in order to make appropriate conditions in interoperability and to insert new standardization of communication between IP-based physical security products regardless of their manufacturer. A particular standard dedicated to Application guidelines is EN 50 132-7 [1] which is recently upgraded to contain even the regulation for IP-based VSS. Nonetheless, a variant research is also completed in this field. Although the question of Effective, Design, Configuration and Use of VSS[2] has been analyzed most frequently, other problems such as Assessment of the impact of VSS[3] or particular steps in the VSS proposal like the Operational requirements manual[4] have been solved as well. Nevertheless, the most of this research which has been accomplished were related to Socio-technical view on VSS.

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Table 1 Suggested VSS building blocks

Location	Activity	Video content analysis by risk level		
		High	Medium	Low
Aisles	Theft, health & Safety	RTDR,OD, PA, AOD,	PA, AOD, OD	OD
ATM	Theft, Assault, fraud	RTDR, OD, QLM, CTA,	OD, QLM	OD
Bar area	ASB, theft, assault	RTDR, PA, CTA	RTDR, CTA	RTDR
Bin areas	Theft, vandalism	OD, AOD	OD, AOD	OD
Car park - vehicle access	VRN	VRN, OD, CTA, AOD	VRN, OD, CTA, AOD	VRN, OD, CTA, AOD
Car park - Parking	Theft, Assault, fraud	PTZ AT, OD, CTA, AOD	PTZ AT, OD, CTA, AOD	CTA, OD
Car Park - Pedestrian access	Any	Recognise - 6fps	Observe - 6fps	Observe - 2fps
Cash counting	Theft, Assault, fraud	Identify - 12.5fps	Identify - 6fps	Identify - 6fps
Concourse / Street	Any	Observe + PTZ - 1ěfps	Observe + PTZ - 6fps	Observe - 2fps
Connections (escalators, lifts,	Theft, fraud	Observe - 6fps	Observe - 6fps	Observe - 6fps
Cycle racks	Any	Recognise - 6fps	Observe - 6fps	Observe - 6fps
Dance floor	Any	Observe - 6fps	Observe - 6fps	Observe - 6fps
Door - Customer	Theft, vandalism	Identify - 12.5fps	Identify - 6fps	Identify - 6fps
Door - Secure	ASB, Theft, Assault	Identify - 12 5fps	Identify - 6fps	Identify - 6fps
Frontage	Any	Observe + PTZ -	Observe - 6fps	Observe - 2fps
Help point	Any	Recognise - 12.5fps	Observe - 6fps	Observe - 6fps
High value items	Any	Recognise 12.5fps	Recognise - žfps	Observe - 6fps
Lift interiour	Activity	Recognise - 6fps	Recognise - 6fps	Observe - 6fps
Loading bay	Theft	Recognise - 6fps	Observe - 6fps	Observe - 2fps
Perimeter	ASB	Detect - 2fps	Detect - 2fps	Detect - 2fps
Phone booth	Theft, vandalism,	Observe - 6fps	Observe - 6fps	Observe - 2fps
Sterile zone	Activity	Detect - 2fps	Detect - 2fps	Detect - 6fps
Stock room	Theft	Recognise - 12.5fps	Observe - 6fps	Observe - 6fps
Taxi rank/Drop-off area	Any	Observe + PTZ - 6fps	Observe + PTZ - 6fps	Observe - 6fps
Tills	Robbery, assault, theft,	Recognise - 6fps	Recognise - 6fps	Observe - 6fps
Toilet access	Any	Observe - 6fps	Observe - 6fps	Observe - 2fps

Therefore, there are still many problems such as implementation of the recent technical innovation, which have to be assessed in more detail.

II. Problem formulation

The VSS are still more often used by numerous entities, ranging from small systems which serve as home surveillance applications to complex systems used for surveillance over large cities. Nonetheless, regardless of their complexity, all systems are influenced by similar conditions. Even though these are closely described in EN 50 132-7, and despite the particularity of the standard, there are some technical features, such as use of DSP as a tool for automatic adaptation of the digital image sensor to different lighting conditions or systemic utilization of the advanced VCA, which were not included in it. Moreover, the methodology of initial processes of the VSS design is also included in EN 50 132-7 where even the Guide to specify CCTV parameters is proposed. The Guide is specified via suggested VSS building blocks. For each building block, the parameters such as the Activity and the Image quality were determined by the particular risk level as shown in Table 1.

As mentioned above, more parameters have to be assigned to these building blocks in order to provide better guidance for potential VSS users. Majority of cameras which are on the market nowadays have been equipped by a DSP unit and still higher percentage also support VCA through Video Management Software (VMS). Thus, it is important to provide sufficient background for user in order to ensure quality and effectiveness of a VSS design.

A. DSP tools

DSP is a microprocessor, which design is optimized for an algorithms used for processing of digitally represented signals.[5] DSP chip which is used in surveillance cameras serve as a tool for digitalization of analog stream outgoing from CCD image sensor and modulating it in order to adjust an image quality. The main functions of DSPs are specified in this subsection in order to provide background needed for its implementation into recent methodology.

The first one is the Back Light Compensation (BLC), which has an ability to eliminate undesirable back light through an automatic adjustment of its contrast and replacing particular levels of white with black ones.[5] The second function is Low Speed Shutter (LSS), which is commonly used for the low light level scenes. This technology enables automatic exposure time extension up to 128 times, therefore it is possible to monitor image up to light level equal 0.02 Lux. Next feature of DSP chip is Highlight Compensation (HCL), which is used for elimination of highlight in particular areas of an image. The areas highlighted are replaced with black image pixels. One of the most useful functions is Wide Dynamic Range (WDR), which helps with gaining detailed information from the underexposed parts of the image, without saturation of well exposed parts. [5] In fact, it is modern and more effective version of BLC. As much as the sensitivity of the image sensor is increased, the signal-noise ratio is increasing as well. In these cases is appropriate to use a Digital Noise Reduction (DNR) or the contemporary version 3D DNR. These functions could increase an effectiveness of image sensor and simultaneously reduce a bit-rate of the particular camera.[5]

A. VCA tools

The Video Content Analysis tools are divided into two main parts. It depends through which device the VCA is proceeded, either IP camera or VMS installed on personal computer (PC) or digital video recorder (DVR), respectively network video recorder (NVR). Nevertheless, there are a lot of functions which are provided by VCA, but only a few of them are applicable for practical use in the recent VSS.

1) Occupancy Detection (OD)

There are occupancy detection sensors specifically designed to recognize the existence of humans within a confined space and count them from any angle. These devices, such as Lyrtech's Intelligent Occupancy Sensor, recognize humans by vision, not by motion. Some video analytics programs determine how many persons occupy a given space by noting the various moving objects, which isn't as accurate as recognizing those moving objects as human. Social gatherings in unique environments may include decorative elements such as balloons or flora, all of which may be misinterpreted as an occupant by simple motion detection. The better video analytics solutions can determine occupancy with non-motion, thus a person who remains motionless is still recognized as present. This avoids the common problem witnessed by people using motion detection light switches, which turn off lights in a room when the person is still, and that person must subsequently wave her arms to turn the lights on again.[6]

2) Area Obstruction Detection (AOD)

Video analytics can be programmed to recognize an open area within the frame and when that area is blocked for an extended period of time. The software is programmed to visually understand what it's monitoring and when that area is obstructed.[6]

3) People Counting (PC)

Much like occupancy protection, people-counting applications must be able to recognize people visually and then count how many enter or exit the facility. Simple motion detection may misread objects as additional people.[6]

4) Queue Length Monitoring (QLM)

Queue length monitoring is a way to automate the processes of controlling the number of people waiting in line. If there's a predetermined threshold, either for security or city code reasons, the software sends an alert to the VMS system along with a priority placement of any related video.[6]

5) Panic Alarm (PA)

While monitoring the traffic flow of people, an incident that causes a number of people to suddenly turn around and run in the opposite direction can be recognized by video analytics software as panic, setting off a number of preprogrammed alerts within the VMS software to present messages, priority positioning for the cameras in that select area, and even inform security personnel on the premises.[6]

Table 1

6) Abandoned Object Detection (ABOD)

In a world where terrorism is a reality, the threat of an abandoned object, which may be a bomb, can't be ignored. Video analytics extends security by turning all cameras designated for the area of coverage into trained observers.
Table 2

When any object has been left at a busy scene for a select period of time, an alarm is sent to security personnel through the VMS interface and even remotely to mobile devices.
This key video analytics feature aids in the timely management of potentially dangerous situations. Abandoned objects detection has also been used to monitor illegal parking and to search the metadata in the archives for select programmed events such as blocked walkways or handicapped parking zones.[6]

7) Camera Tampering Alarm (CTA)

While intelligent scene verification monitors the actual scene, camera tampering monitors the camera and lens for obstacles and obstructions. Spray paint and/or paintball guns can render a camera useless without security acknowledging it, unless there's an alarm set to warn of wrongdoing. Once the system recognizes vandalism, the video analytics can turn any other PTZ cameras in the vicinity toward that location for observation. Motion detection can then activate an alarm within the VMS software to notify security of a potential culprit.[6]

III. Specification of Model Scenes

Model scenes could be divided into seven groups which have relatively comparable parameters in final results.
For the purposes of this research these categories was created:

- Services
- Cash manipulation
- Zones
- Parking
- Entrance
- Building block
- Assets movement

Systemic assignment is created in Table 3. A brief description of these categories is created in order to provide more sophisticated idea for purposes of semi-quantitative analysis.
Categories are entitled according their core properties. The first big category is Building blocks which are represented by scenes, which are most commonly occurred on the street around the particular buildings. Other one is called Cash manipulation, where the commons are already expressed in the name. Typical attribute of these scenes is high demands on the security, because of easy to steal actives manipulation. Next interesting group is called Entrance. Nevertheless, several entrances are common in other groups as well. For example in the group of scenes which fall into parking. These scenes have considerable amount of similar properties, which is in our case illustrated via values. The ratio of usability of the QLM and PC VCA tool should be considered as well. Another unique group of scenes is that called Zones, Typical for the extent areas with restricted accessibility. Probably the most extent group is created by Services. It was difficult to specify this category. Nonetheless, certain affinities are greatly obvious such a direct contact with people, user presence on the scene and huge amount of people monitored.
The similarity of particular scenes divided into groups is definite and this fact could help in the VSS equipment solution process.

Table 2 Group assignment to suggested building blocks

Building block	Aisles
Cash manipulation	ATM
Services	Bar area
Zones	Bin areas
Parking/Entrance	Car park - vehicle access
Parking	Car park - parking area
Parking/Entrance	Car park - pedestrian access
Cash manipulation	Cash counting
Building block	Concourse/Street
Services	Connections (escalators,lifts)
Parking	Cycle racks
Services	Dance floor
Entrance	Door - Customer
Entrance	Door - Secure
Building block	Frontage
Services	Help point
Cash manipulation	High value items
Services	Lift interiour
Assets movement	Loading bay
Building block	Perimeter
Sevices	Phone booth
Zones	Sterile zone
Assets movement	Stock room
Parking	Taxi rank/Drop-off area
Cash	Tills
Entrance	Toilet access

IV. Purpose of the Operational Requirements

The Operational Requirements states clearly what the customer expects the functions of the system to do. If there is an agreement between system designer and customer, the Operational Requirements could be defined within the System Design Proposal and Specification. If so, this should be clearly stated within the document. The development / design process encourages clear thinking about who will use the VSS system, where and when it will be used and in particular the purpose of the VSS. It is produced by VSS owners, operators and anyone who intends to use information from the CCTV system. The later stages of development of the OR shall involve those with the necessary skills to convert statements into a technical specification and test procedures.

At appropriate stages checks shall be made to ensure that the proposed implementation will meet the Operational Requirements. Without an Operational Requirement and a matching test procedure there is no practical methodology to assess whether the system can meet its required purpose.[1]

Table 3 Systemic implementation of the VCA

Location	Activity	Video content analysis by risk level		
		High	Medium	Low
Aisles	Theft, health & Safety	RTDR,OD, PA, AOD,	PA, AOD, OD	OD
ATM	Theft, Assault, fraud	RTDR, OD, QLM, CTA,	OD, QLM	OD
Bar area	ASB, theft, assault	RTDR, PA, CTA	RTDR, CTA	RTDR
Bin areas	Theft, vandalism	OD, AOD	OD, AOD	OD
Car park - vehicle access	VRN	VRN, OD, CTA, AOD	VRN, OD, CTA, AOD	VRN, OD, CTA, AOD
Car park - Parking	Theft, Assault, fraud	PTZ AT, OD, CTA, AOD	PTZ AT, OD, CTA, AOD	CTA, OD
Car Park - Pedestrian access	Any	PC, OD, CTA, PA	PC, OD, CTA	OD, CTA
Cash counting	Theft, Assault, fraud	RTDR, OD, AOD, CTA	RTDR, OD, AOD, CTA	RTDR, OD, AOD, CTA
Concourse / Street	Any	PA, ABOD, AOD	PA, ABOD, AOD	PA, ABOD
Connections (escalators, lifts,	Theft, fraud	OD, ABOD, PA	OD, ABOD	OD
Cycle racks	Any	AOD, CTA, ABOD	AOD, CTA	AOD, CTA
Dance floor	Any	PA, OD, PC, RTDR	PA, OD, PC,	OD
Door - Customer	Theft, vandalism	AOD, CTA, OD, ABOD	AOD, CTA, OD	OD
Door - Secure	ASB, Theft, Assault	OD, CTA, ABOD, AOD	OD, CTA, AOD	OD
Frontage	Any	PTZ AT, OD, CTA, ABOD	OD, CTA, ABOD	OD
Help point	Any	OD, PC, PA, QLM	OD, PC	OD
High value items	Any	OD, CTA, AOD	OD, CTA, AOD	OD, CTA, AOD
Lift interiour	Activity	OD, CTA, AOD, PC	OD	OD
Loading bay	Theft	OD, CTA, AOD, ABOD	OD, CTA, AOD	OD
Perimeter	ASB	OD, CTA, AOD	OD	OD
Phone booth	Theft, vandalism,	OD, CTA, AOD, ABOD	OD	OD
Sterile zone	Activity	OD, CTA, AOD	OD,CTA	OD
Stock room	Theft	OD, PC, CTA, AOD	OD, CTA, AOD	OD
Taxi rank/Drop-off area	Any	PTZ AT, OD, PA, ABOD	PTZ AT, OD	OD
Tills	Robbery, assault, theft,	OD, CTA, AOD, QLM	OD, CTA, AOD, QLM	OD, QLM
Toilet access	Any	OD, PC, CTA, AOD	OD, PC,	OD, PC,

V. Field of view

Camera placement shall be based on achieving an optimum view which shall not be compromised merely for ease of installation. When setting up a camera field of view it is important to consider other environmental or scene specific content, for example:

Foliage: There is a seasonal variation in foliage, which could block the view. Trees and plants grow over time which could also block the view. Illumination: There might be spot lighting from external light sources and time controlled lighting which could impact the view.

Sunlight: Depending on time of day and seasonal variations the position of the sun could produce glare or provide poor illumination conditions. Reflections: Windows, buildings, bodies of water or any other reflective objects can result in poor or excessive illumination conditions which can compromise the desired captured image.

Street furniture / signage: Temporary or new permanent structures such as signs or other buildings may block the field of view. Scene activity: If a specific task is required ensure that other scene activity does not compromise the desired image capture, for example a busy footpath in front of a doorway could occlude an identification shot. Where person identification is the main purpose of the camera, the camera should be mounted around head height, cameras mounted significantly above head height may not be able to provide a full view of a person's face.

VI. Problem Solution

Particular DSP and VCA tool could be used in different situations, thus the qualitative assessment is done to implement these functions into the recent methodology, which is presented in EN 50 132-7, Annex D. The final implementation is shown in Table 3.

A. Evaluation process of the particular locations methodology

Semi - quantitative evaluation of the Video content analysis applicability by the particular risk level has been accomplished to provide more specific background of the problem. A similar model scenes or locations as in previous systemic implementation was used, but each of them is evaluated precisely via following methods. The first one is ordinary deduction in combination with usage of the empirical evidences. The second is the modeling of the operational situation provided through Video Surveillance System design software VideoCad Professional 7. The applicability of particular tool of the Video content analysis is represented through the five point scale system. The specification of individual value is formulated in Table 4. The primary contribution of the VCA tools for the Video Surveillance System function is the factor which could be defined as an efficiency ratio. The efficiency ratio for particular location is represented by assigned values as is shown in the Table 3.

Table 4 Specification of evaluating parameters

Specification of evaluating parameters	
Description of the parameter	Value
Negligibly increasing effectiveness of the VSS	1
Slightly increasing effectiveness of the VSS	2
Increasing effectiveness of the VSS	3
Greatly Increasing effectiveness of the VSS	4
Diametrically increasing effectiveness of the VSS	5

This is also the main contribution of this research to provide sophisticated guidance in the choosing the right equipment process.

VII. Semi-quantitative applicability evaluation

In order to define applicability of particular VCA tools the results of the evaluation are illustrated via Table 4. There are two main sections in this table and the assessment by three levels of risk is also included.

Table 5 Semi-quantitative evaluation of the VCA

Location	Semi-quantitative evaluation of the Video content analysis by risk level																							
Risk level	High								Medium								Low							
VCA	PTZAT	OD	AOD	PC	QLM	PA	ABOD	CTA	PTZAT	OD	AOD	PC	QLM	PA	ABOD	CTA	PTZAT	OD	AOD	PC	QLM	PA	ABOD	CTA
Aisles	5	4	5	2	1	3	3	4	4	3	4	1	1	3	2	3	3	2	3	1	1	3	1	1
ATM	3	4	5	3	3	1	5	5	2	3	5	2	2	1	3	5	1	3	4	1	1	1	2	5
Bar area	1	3	3	1	3	4	3	3	1	3	3	1	3	3	3	3	1	1	2	2	3	3	3	3
Bin areas	4	5	5	3	1	1	2	5	3	4	4	1	1	1	1	5	2	3	4	1	1	1	1	5
Car park - vehicle access	1	5	5	1	3	1	3	5	1	5	4	1	3	1	1	4	1	5	3	1	1	1	1	3
Car park - parking area	5	4	4	1	1	3	4	4	4	3	4	1	1	2	3	4	2	3	3	1	1	1	2	4
Car park - pedestrian access	3	4	4	4	1	3	3	4	3	3	3	4	1	3	2	4	2	3	3	3	1	2	2	4
Cash counting	1	5	5	1	1	1	5	5	1	5	5	1	1	1	4	5	1	4	5	1	1	1	3	5
Concourse/Street	3	2	4	3	1	5	4	4	2	1	3	2	1	5	3	2	2	1	3	1	1	5	3	2
Connections (escalators,lifts)	4	4	4	4	3	4	4	4	3	3	4	3	2	3	4	4	3	3	3	2	1	3	3	4
Cycle racks	3	4	4	1	1	3	5	4	2	3	4	1	1	3	4	3	2	3	3	1	1	2	3	2
Dance floor	2	2	3	3	1	5	4	3	1	1	3	2	1	4	3	3	1	1	2	2	1	4	3	3
Door - Customer	1	3	4	5	5	2	4	4	1	3	4	4	4	1	3	3	1	2	4	5	4	1	3	3
Door - Secure	3	5	5	3	2	1	5	5	3	5	4	2	1	1	5	4	2	4	4	1	1	1	4	4
Frontage	4	4	4	2	3	3	4	4	3	3	3	1	2	2	3	3	2	3	3	1	1	1	3	3
Help point	3	3	3	4	4	4	3	3	2	3	3	3	3	3	2	2	1	2	2	3	3	3	2	3
High value items	2	5	5	1	1	1	5	5	1	5	5	1	1	1	4	5	1	4	4	1	1	1	4	5
Lift interiour	1	4	3	4	1	1	4	5	1	4	3	3	1	1	3	5	1	3	3	3	1	1	3	5
Loading bay	4	4	4	1	4	2	4	4	3	4	4	1	4	1	4	4	3	3	3	1	3	1	3	3
Perimeter	5	4	4	1	1	1	3	4	4	4	4	1	1	1	3	4	4	3	3	1	1	1	2	4
Phone booth	1	5	4	3	4	2	3	5	1	4	4	2	3	1	3	5	1	4	3	1	2	1	2	4
Sterile zone	4	5	5	1	1	1	4	4	3	5	4	1	1	1	4	4	3	4	4	1	1	1	3	4
Stock room	3	4	5	1	1	1	3	4	3	3	5	1	1	1	3	4	2	3	4	1	1	1	3	3
Taxi rank/Drop-off area	2	3	3	1	1	3	5	3	1	3	3	1	1	3	5	3	1	3	3	1	1	2	4	3
Tills	1	4	5	1	4	1	3	5	1	3	4	1	4	1	2	4	1	3	4	1	3	1	2	3
Toilet access	1	3	3	3	4	1	2	3	1	3	3	3	3	1	2	3	1	2	3	2	3	1	2	3

It is obvious that the VCA tools are more usable within the higher risk levels. The results are relatively varied for diverse locations. Despite of these facts the practical appliance of the VCA tools, have a significant influence on the system effectiveness. The most often applicable VCA tools are the AOD and CTA, mostly because these functions are applicable in wide range of the model locations, even in lower risk levels. In the other hand the utility of functions such QLM or PC is quite limited. The evaluation was done for a various locations due to the core contribution of this paper is design of the base background for further testing and scene modeling.

VIII. Results

Final results are illustrated through the figures, where the particular dependencies are shown. In figure 2 dependency of the value on risk level is illustrated. In the figure 1, summation of the evaluated values is executed for each model scene. From the bar graph is obvious that the effectiveness of entire VSS of particular scene is increasing simultaneously with the risk level. The highest value for a high risk level has been achieved in connections scene. The lowest has been gained by toilet access.

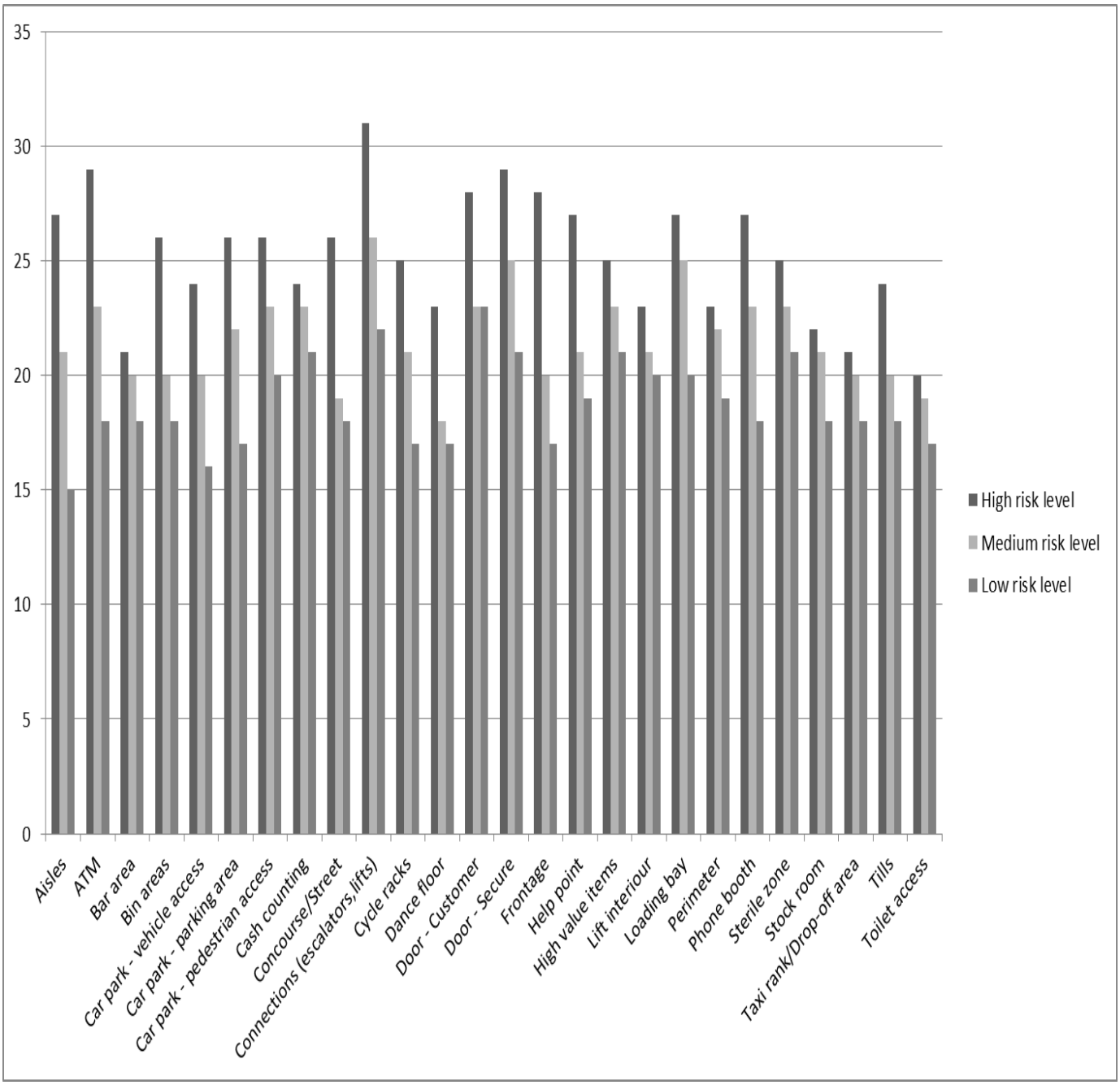

Fig. 1 Illustration of the risk level ration dependency

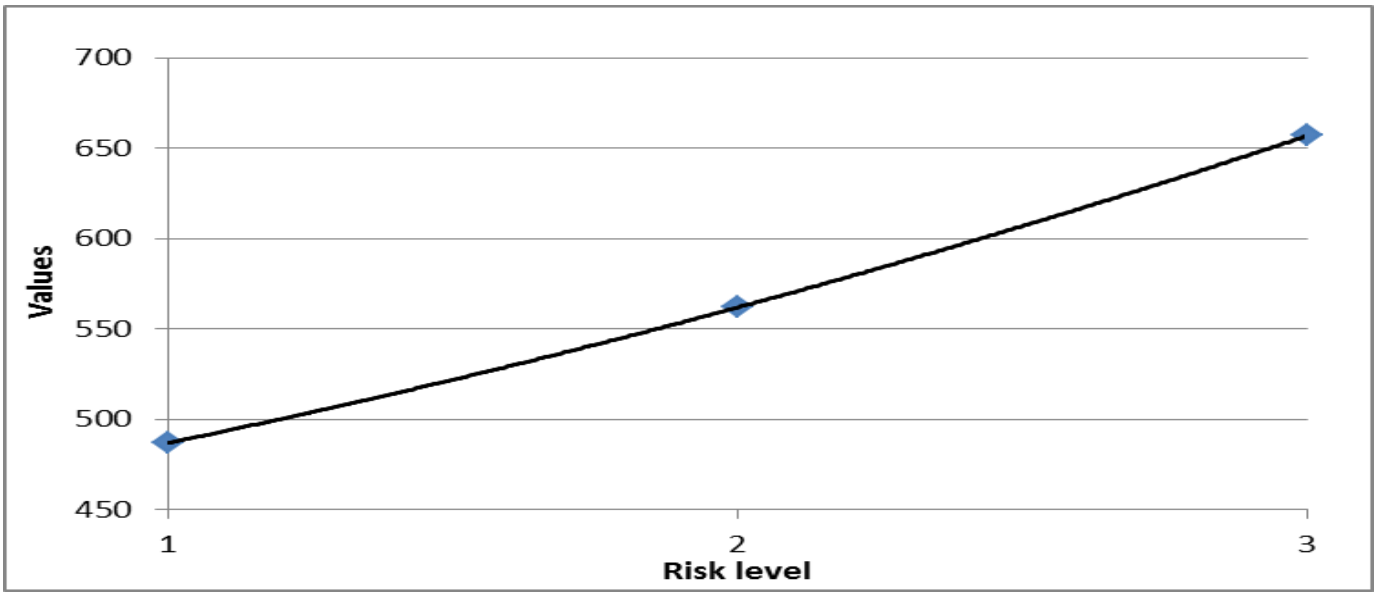

Fig. 2 Curve of progression of values by risk level

Table 6 Final specification of the monitored scenes according to its values

	Location	Semi-quantitative evaluation of the Video content analysis by risk level																							
	Risk level	High								Medium								Low							
	VCA	PTZAT	OD	AOD	PC	QLM	PA	ABOD	CTA	PTZAT	OD	AOD	PC	QLM	PA	ABOD	CTA	PTZAT	OD	AOD	PC	QLM	PA	ABOD	CTA
Building block	Aisles	5	4	5	2	1	3	3	4	4	3	4	1	1	3	2	3	3	2	3	1	1	3	1	1
Building block	Concourse/Street	3	2	4	3	1	5	4	4	2	1	3	2	1	5	3	2	2	1	3	1	1	5	3	2
Building block	Frontage	4	4	4	2	3	3	4	4	3	3	3	1	2	2	3	3	2	3	3	1	1	1	3	3
Cash manipulation	ATM	3	4	5	3	3	1	5	5	2	3	5	2	2	1	3	5	1	3	4	1	1	1	2	5
Cash manipulation	Cash counting	1	5	5	1	1	1	5	5	1	5	5	1	1	1	4	5	1	4	5	1	1	1	3	5
Cash manipulation	Tills	1	4	5	1	4	1	3	5	1	3	4	1	4	1	2	4	1	3	4	1	3	1	2	3
Cash manipulation	High value items	2	5	5	1	1	1	5	5	1	5	5	1	1	1	4	5	1	4	4	1	1	1	4	5
Parking/Entrance	Car park - vehicle access	1	5	5	1	3	1	3	5	1	5	4	1	3	1	1	4	1	5	3	1	1	1	1	3
Parking	Car park - parking area	5	4	4	1	1	3	4	4	4	3	4	1	1	2	3	4	2	3	3	1	1	1	2	4
Parking/Entrance	Car park - pedestrian access	3	4	4	4	1	3	3	4	3	3	3	4	1	3	2	4	2	3	3	3	1	2	2	4
Parking	Cycle racks	3	4	4	1	1	3	5	4	2	3	4	1	1	3	4	3	2	3	3	1	1	2	3	2
Services	Connections (escalators,lifts)	4	4	4	4	3	4	4	4	3	3	4	3	2	3	4	4	3	3	3	2	1	3	3	4
Services	Dance floor	2	2	3	3	1	5	4	3	1	1	3	2	1	4	3	3	1	1	2	2	1	4	3	3
Services	Help point	3	3	3	4	4	4	3	3	2	3	3	3	3	3	2	2	1	2	2	3	3	3	2	3
Services	Lift interiour	1	4	3	4	1	1	4	5	1	4	3	3	1	1	3	5	1	3	3	3	1	1	3	5
Services	Phone booth	1	5	4	3	4	2	3	5	1	4	4	2	3	1	3	5	1	4	3	1	2	1	2	4
Entrance	Door - Customer	1	3	4	5	5	2	4	4	1	3	4	4	4	1	3	3	1	2	4	5	4	1	3	3
Entrance	Door - Secure	3	5	5	3	2	1	5	5	3	5	4	2	1	1	5	4	2	4	4	1	1	1	4	4
Entrance	Toilet access	1	3	3	3	4	1	2	3	1	3	3	3	3	1	2	3	1	2	3	2	3	1	2	3
Assets movement	Loading bay	4	4	4	1	4	2	4	4	3	4	4	1	4	1	4	4	3	3	3	1	3	1	3	3
Assets movement	Stock room	3	4	5	1	1	1	3	4	3	3	5	1	1	1	3	4	2	3	4	1	1	1	3	3

IX. Conclusion

The methodology provided could serve as a guide through the effective VSS design. Nevertheless, more work has to be done in this field.

It is necessary to realize more practical testing in order to gather relevant quantitative results. Then sophisticated results could be achieved. Moreover, it is planed that more testing of particular VCA tools will be accomplished in the future research. The first step is the Semi-quantitative evaluation and the simulation of the real crime activities is the idea of the future research.

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