

## Re-thinking the cost of supply chain security

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**Abstract** Post 9/11 we have witnessed the introduction and further strengthening of a range of trans-border security programs designed to protect international supply chains against acts of unlawful interference. In some cases compliance with these programs is mandatory. In other cases compliance results in a preferential treatment by appropriate authorities. To a great extent, these programs comprehend the introduction of situational measures. In most instances, however, operators within the supply chain—being made responsible for their actual implementation—are left with limited guidance. In this paper it is argued that a lack of guidance may result in measures being introduced without taking full account of their potential consequences. Based on an analysis of previous research findings and on the outcome of a literature review, direct and indirect implementation costs have been differentiated from a range of (consequential costs provoked by) potential reverse effects, and from a series of generic preconditions, enabling practitioners in industry to conduct a proper cost analysis and come to an informed decision on what particular measure(s) best to implement. It is argued that criminology and management science can support this decision making process, provided that policy makers allow operators a certain freedom of choice between alternative measures and approaches.

### Introduction

‘What have you criminologists been doing all these years?’ This quote was taken from Martin Gill’s introduction to the first volume of ‘Crime at Work’ [1]. According to Gill, crime in the business environment had been a marginal concern for most criminologists at the time. Most tended to see crime and business solely in terms of corporate crime, white collar crime and fraud; while in reality virtually any crime can occur at the workplace; and the business or its staff, customers or

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contractors can either be the offender or the victim [1]. This paper highlights a similar concern, be it of a somewhat different nature.

Post 9/11 we have witnessed the introduction of a range of trans-border security programs designed to protect international supply chains against acts of unlawful interference [2–4]. The scene was set by US Government with the introduction of the Container Security Initiative (CSI), the Customs-Trade Partnership Against Terrorism (C-TPAT), and the Advanced Manifest Rule (AMR). In the European Union, the International Ship and Port Facility Security (ISPS) Code was adopted in December 2002 as an amendment to the SOLAS Convention, describing minimum requirements for security of ships and ports.<sup>1</sup> In the area of civil aviation and air cargo security, Regulation (EC) No. 2320/2002 enabled for a European framework with intense levels of security in the form of rules and measures with detailed, legally binding specifications and checks,<sup>2</sup> and in 2003 the European Commission communicated two main goals with respect to the future of customs authorities, introducing—amongst other—the European Authorized Economic Operator concept.<sup>3</sup> Over the past decade, most of these programs have been strengthened following further incidents and changing threat patterns provoking government and industry intervention.<sup>4</sup> In some cases compliance to them is mandatory for operators in the logistics chain. In other instances compliance results in a preferential treatment by appropriate authorities, as is the case for the Authorized Economic Operator program that allows for reduced security checks by Customs and—as such—for a faster transfer of goods through so-called “green lanes” [2]. In all cases, operators are being made responsible for the introduction of preventive controls, putting security and compliance high on the agenda and making them an integral part of contemporary supply chain management.

In most if not all instances, supply chain security programs comprehend the introduction of situational measures, and in many cases operators in the industry are left with limited guidance on how best to implement them [5]. A study conducted in 2009 into the effectiveness, efficiency and acceptability of situational crime prevention in international supply chain security programs, identified a series of costs and implementation problems reported by end-users [4, 5]. In the same study it was argued that an ‘ex ante’ consideration of preventive measures may prove to be extremely beneficial to the success of future programming. This consideration is to take place prior to the actual implementation phase, and the outcome can be applied to help prioritize and rank potential interventions and to decide on the most promising and feasible one(s) [4]. It goes without saying that, in order to enable operators in the supply chain to consider alternative options, they must first be

<sup>1</sup> This code was incorporated into European legislation with Regulation (EC) No. 725/2004 of the European Parliament and of the Council of 31 March 2004 on enhancing ship and port facility security, OJ, L 129/6, 29 April 2004.

<sup>2</sup> Regulation (EC) No. 2320/2002 of the European Parliament and of the Council of 16 December 2002 establishing common rules in the field of civil aviation security, OJ, L355/1, 30 December 2002.

<sup>3</sup> Commission of the European Communities, Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee on a simple and paperless environment for Customs and Trade and on the role of customs in the integrated management of external borders, COM (2003) 452, Brussels, 24 July 2003.

<sup>4</sup> As an example, recent interceptions of improvised explosive devices originating from Yemen have triggered US and EU governments to further enhance air cargo security regulations.

allowed a certain freedom of choice. This is currently the case in some but by far not all programs. As where customs supply chain security programs such as the European Authorized Economic Operator program clearly indicate the scope of the required interventions, leaving the decision on what particular safeguards to introduce open to some extent; business driven initiatives such as the TAPA Freight Security Requirements<sup>5</sup> only list a range of very specific situational measures that need to be introduced in order to reach and maintain compliance.

The present paper further elaborates on the above and aims to identify what costs and preconditions need to be considered in order to come to an informed decision on what measure(s) best to implement. It aims to differentiate the cost components associated with the introduction of a specific measure from a range of reverse effects that may result in consequential costs; and from a set of preconditions that need to be in place in order for the introduction to be feasible and successful. The decision to focus on the costs of situational crime prevention is instigated by a genuine concern that operators risk to be left in the cold, and, out of ignorance or due to a lack of guidance, risk to implement measures without taking full account of its potential consequences. As an understanding of the situational calculus made by offenders in specific kinds of crime is the key to effective prevention [6], so is an understanding of the costs (and benefits) of the range of situational crime prevention measures to choose from. As Tilley [7] argues: "it should be clear that crime prevention is ineluctably complex. This means that those for whom crime reduction or community safety is a specialist responsibility either as policy-maker or practitioner, need to have a broad grasp of the theory, evidence, circumstances, options, contexts, ethics and possible consequences of varying responses if they are to make informed decisions". It goes without saying that those responsible for implementing crime prevention programs within their industry or individual company require a commensurate level of knowledge, expertise and/or guidance.

The scope of the attached paper is limited to an identification and consideration of the cost of introducing situational measures. As such it aims to move away from a high level theoretical discussion on the pro's and contra's of situational crime prevention compared to more traditional criminological approaches, as well as from a debate on who should bear the cost of crime prevention. Although space limitations do not allow a detailed coverage of the situational perspective, it seems appropriate to provide a brief introduction to its theoretical base and to the set of situational techniques available to end-users.

### **Situational crime prevention**

Most criminological theories have traditionally been concerned with explaining why certain individuals are more likely to engage in criminal behaviour compared to others. They refer to particular biological, biochemical or psychological dispositions

<sup>5</sup> The TAPA Freight Security Requirements (FSR) have been established by security professionals within the high-tech industry to address the nature by which high-tech products and materials are handled, warehoused and transported as they move throughout the supply chain (source: [www.tapaemea.com](http://www.tapaemea.com), accessed 18 November 2010).

or influences; inherited traits; a range of social factors or conditions such as poor education, poverty, inadequate socialization, weak bonds to society, weak morals; etc. [8, 9]. Likewise, much crime prevention effort has gone into trying to lessen these dispositions or influences [7]. In recent decades, various criminological theories have influenced our understanding of the importance of settings and places in crime prevention efforts [10]. As Clarke [8] argues, they emphasize that the commission of a crime requires not only the existence of a motivated offender, but also the opportunity for crime. Situational crime prevention relates to the latter group of theories. As such it is an approach to crime prevention that focuses not upon changing offenders, but on modifying the settings (with its situational factors) in which crime occurs [8].

The concept of situational crime prevention was first introduced in the late 1970's by a team of scholars working in the UK Home Office [11]. Studies on institutional treatments for delinquents undertaken by the Home Office Research Unit provided a stimulus for the founding of its theoretical base, together with two independent but related strands of policy research in the United States: Oscar Newman's concept of 'defensible space' (1972), and Jeffery's concept of crime prevention through environmental design (1971) [11]. The theoretical development of situational crime prevention was further strengthened by the development of routine activity and rational choice theory [11]. According to rational choice theory, offenders make rational decisions when carrying out a criminal act: if the costs of exploiting a criminal opportunity are perceived as being too high, or if an opportunity is reduced or removed altogether, the offender will cease the activity or look for another and better opportunity [12]. Routine activity theory argues that offenders are but one element in a crime, and perhaps not even the most important element. The routine activity approach emphasizes how illegal activities feed on routine activities: everyday life sometimes delivers temptations without controls [13]. According to Cohen and Felson 'crime occurs when a motivated offender and suitable target (or victim) converge in space and time in the absence of a capable guardian' [11]. Routine activity, rational choice and crime pattern theory—sometimes referred to as 'opportunity theories' [14] or 'crime theories'—all give an important role to situational factors in crime. Although somewhat different in focus, they provide a solid theoretical base for the concept of situational crime prevention: 'routine activity as a "macro" theory that seeks to explain how changes in society expand or contract opportunities for crime; crime pattern theory as a "meso" theory that seeks to explain how offenders seek or stumble across opportunities for crime in the course of their everyday lives; and the rational choice perspective as a "micro-level" theory that deals with the decision-making processes that result in an offender choosing to become involved in crime and selecting specific crimes to commit' [14].

The set of situational crime prevention measures or techniques has evolved quite significantly over the past years. The original formulation of situational crime prevention included an eight-category classification of opportunity-reducing techniques of which some had proven to be useful while the remainder required modification [11]. In his first edition of 'Situational Crime Prevention' (1992), Clarke presents a revised classification of 12 techniques, adding new categories and re-labelling existing ones. These 12 have later (1997) been expanded by Clarke and

Homel to 16, including a new category of ‘removing excuses for crime’. Finally, in response to Wortley’s remarks on controlling situational precipitators [15, 16], Cornish and Clarke expanded the techniques further to 25 by including a category ‘reducing provocations’. As such the classification of preventive techniques has grown in step with the expanded theoretical base of situational prevention [14]. Table 1 provides a full overview of situational techniques, listed under five basic strategies: (1) increasing the perceived effort, (2) increasing the perceived risk, (3) reducing the anticipated rewards, (4) removing excuses and (5) reducing provocations.

## Research design

In order to develop an overview of potential costs associated with the introduction of situational crime prevention in a business environment, previous research findings were combined with the outcome of a thorough literature review, covering the existing body of knowledge on situational crime prevention. Cost factors and implementation problems that had been identified earlier in a study conducted into the effectiveness, efficiency and acceptability of situational crime prevention in the international supply chain [5], were compared with those identified in literature, and combined into an all encompassing inventory. This initial inventory was then analyzed further in order to differentiate (financial, ethical and esthetical) implementation costs from a range of potential reverse effects (i.e. consequential costs resulting from the implementation), and from a series of generic preconditions that relate to the introduction of preventive measures in general. These have then be incorporated into a conceptual model designed to identify the scope of an ex ante consideration of the various cost components in a generic program design. Finally it was explored to what extent criminology and management science can be of any benefit in enabling policy makers and practitioners to conduct a proper cost analysis and come to an informed decision on what particular measure(s) best to implement.

**Table 1** Situational crime prevention techniques ([14]: 46–47)

Increase the effort	Increase the risks	Reduce the rewards	Reduce provocations	Remove excuses
Harden targets	Extend guardianship	Conceal targets	Reduce frustration and stress	Set rules
Control access to facilities	Assist natural surveillance	Remove targets	Avoid disputes	Post instructions
Screen exits	Reduce anonymity	Identify property	Reduce emotional arousal	Alert conscience
Deflect offenders	Utilise place managers	Disrupt markets	Neutralise peer pressure	Assist compliance
Control tools / weapons	Strengthen formal surveillance	Deny benefits	Discourage imitation	Control drugs / alcohol

## Implementation problems and (consequential) costs

As part of a study conducted in 2009 into the effectiveness, efficiency and acceptability of situational crime prevention in the international supply chain, operators with relevant experience in implementing the European Air Cargo Security Regulations and the TAPA (Transported Asset Protection Association) Freight Security Requirements were asked to qualify the (perceived) effectiveness of the various measures, and to report on any implementation problems they had experienced [4, 5]. The study revealed a series of costs and implementation problems relating to the availability of certain measures that are required by policy makers (e.g. limited abilities to verify information across borders and legal limitations to conduct pre-employment or criminal history checks); to their practicability and impact on core business processes; to the (financial and human) resources required to implement and maintain them; and to their negative impact on the (perceived) freedom of movement and privacy of staff [4]. They further relate to the level of knowledge and expertise required for assessing, evaluating, prioritizing and tackling criminal risks; to the level of (user) belief in their effectiveness; and to the level of awareness and commitment of end-users and other stakeholders [4]. Similar concerns have been raised in criminological literature on situational crime prevention, both by its advocates and critics. These concerns relate to a variety of areas such as to the financial, ethical and esthetical cost related to the implementation of situational measures; and to various reverse effects that may result from the implementation (see *infra*). As argued by Duff and Marshall [17], the introduction of any measure 'brings some benefits and imposes some costs, such as the material resources required to implement it, the degree of inconvenience it creates, and its possible deleterious impact on such interests as freedom, autonomy or privacy'.

*Financial (or monetary) costs* relate to the fixed and variable costs associated with the implementation of a certain measure.<sup>6</sup> A review conducted into the monetary costs and benefits of 13 situational crime prevention projects reported on between 1977 and 1999, focused on a range of cost items such as management and overhead costs, personnel costs (e.g. wages of surveillance staff, ...), capital expenditures, cost of (security) equipment and services, maintenance costs, etc. [18]. Often the implementation of security controls in a business environment has an impact on certain core processes (e.g. the introduction of X-ray screening, which delays the normal operating procedure and therefore adds additional costs to the import or export process). Obviously the cost resulting from that impact needs to be taken into account in the total (monetary) cost calculation. As Laycock [19] rightly states, some ideal responses may be far too expensive to be acceptable in financial terms. It is important therefore that proposals are realistic and not over-ambitious or over-expensive. Furthermore, being expensive in financial terms does not qualify as a guarantee for success. As Gill [1] argues, the most effective crime prevention measures are often cheap or even free. It has long been established, for example, that

<sup>6</sup> Fixed costs are expenses that are not dependent on the level of goods or services produced or sold, while variable costs are considered to be expenses that change in proportion to the activity of a business (source: <http://www.accountingtools.com>, accessed 9 November 2010).

signs of occupancy are the factor most likely to deter potential burglars of a domestic dwelling, making the encouragement not to leave a note of absence on the front door, or not to let the newspapers build up in the letter-box, an effective and cost-efficient preventive measure [1]. In any case, the monetary cost of introducing a certain measure should be carefully measured and balanced against the cost of alternative solutions, as measures that may initially be thought of as being less expensive than alternative options, may actually prove to be the contrary, as illustrated in a study on the cost of electronic article surveillance in retail stores, where it was found that the cost of tagging goods eventually proved to be the equivalent of employing a full-time member of staff for 52 weeks [20].

Solutions to prevent crime may be effective and cost-efficient, but that does not automatically make them acceptable without further consideration. When applied without reflection, or by their very nature, preventive measures can easily backfire and lower the quality of life in our society. Certain members of society may become labeled, feelings of intolerance and distrust may be stimulated, social conduct may be hindered, and human rights violated [21, 22]. Translated into a workplace environment, staff members may feel labeled and discriminated, or hindered in their freedom of movement, alienating them from their colleagues and from their employer. Privacy rights may become violated, feelings of intolerance and distrust may be provoked, etc. As Duff and Marshall [17] put it, 'if an employer decides to introduce exit searches on employees as they leave work, not only the cost-effectiveness of this measure, but also the attitude it displays towards the employees should be questioned, as well as the conception it implies of their role in the enterprise in which they are engaged'. Other examples from literature that illustrate the potential *social (or ethical) cost* of situational crime prevention in a workplace environment, include a thoughtless use of access control measures in public or semi-public spaces such as shopping malls, resulting in the fact that individuals profiled as posing an increased risk may lose access to public spaces which formerly were accessible to all [23]; the application of CCTV in retail security which may be seen by customers and staff as operating to the detriment of privacy, free association and other civil liberties [24]; monitoring one's activity on the Internet [16]; and passenger profiling at airports which may involve the violation of personal freedom [25]. With its use of electronic hardware, the concept of situational crime prevention raised the spectre of totalitarian, "big brother" forms of state control [11]. While the ethical and social cost of situational crime prevention is obvious in some cases, it shouldn't be ignored that not every measure is likely to be susceptible to the critical concerns raised above, and that 'people are willing to surrender some freedoms or endure some inconvenience in specific contexts if they gain protection from crime' [14]. A good example of the latter is the general acceptance of the need for additional precautions when checking-in on a passenger aircraft [14].

Apart from their financial and social cost, certain measures may have a negative impact on (the esthetics of) the environment and, as such, pose an additional cost compared to those that are equally effective but blend in with their surroundings. Examples of *esthetical costs* derived from literature include the installation of floor-to-ceiling turnstile railings in subway stations, creating a prison-like, 'draconian' environment [8]; gating-off pay phones in public spaces to prevent shoulder surfing

[26]; or the installation of bollards or shutters outside listed buildings or in older market towns [27].

Finally there has been extensive publishing on various *reverse effects* that may result from the implementation of situational crime prevention, effects that—again—may result in a range of consequential costs. As Grabosky [28] argues, the ways in which crime prevention programs may become derailed are numerous and diverse. The most common side effects that are referred to in literature are effects of displacement [7, 8, 10, 22]. This is the phenomenon where the introduction of preventive measures results in crime being displaced elsewhere (i.e. ‘geographical’ or ‘spatial displacement’), to some other time or target (i.e. ‘temporal’ or ‘target displacement’), being committed in another way (i.e. ‘tactical displacement’), or being substituted for some other kind of offense (i.e. ‘crime type’, ‘functional’ or ‘offence displacement’) [11]. Target, tactical and crime type displacement have been examined in studies on the introduction of steering column locks to prevent car theft [29, 30], and on the value of anti-bandit screens to prevent post office robberies [31]. Temporal displacement has been analysed in studies on the effectiveness of bike patrols to prevent auto theft in commuter lots [32], and of improved street lighting [33]; and geographical displacement has been addressed in studies on the introduction of caller-ID to deter obscene phone callers [34] and on the use of CCTV [35, 36], to cite but a few. Furthermore, one may actually produce crime and do more harm than good in the course of combating it. As Marx argues, ‘the frustration that results from blocked criminal opportunities may lead to excessive violence or to an instrumental reliance on more forceful means of goal attainment’ [28]. As an example, escalating effects have been examined in studies on check frauds in Sweden [37]; on robbers’ perceptions of enhanced security measures [35]; and on decision-making practices of armed robbers [38]. Some initiatives or measures may inspire adaptive behaviour on the part of the offenders that can entail more inventive, devious or violent activity [14, 28]; or by dramatising certain aspects of unwanted behaviour, one may actually advertise that behaviour, either by bringing it to the attention of those who would otherwise be oblivious or only vaguely aware, or by enticing the potentially rebellious, as indicated by Morrison and O’Donnell in their study on offender’s decision-making processes [28, 38].

### Further analysis and classification

Further analysis enables us to list the above under three broad categories: a set of generic preconditions; a range of financial, ethical and esthetical costs related to the implementation of a measure; and a number of potential reverse effects that may result from that implementation (see *infra*). While the first are common to any intervention, the latter two are specific to the measure that is under consideration (see also Table 2).

Certain *preconditions* need to be in place in order for any intervention to be effective. This is the case for the practicability and availability of a measure to end-users, as well as for the knowledge and expertise that is required to evaluate and implement it. Sampson et al. [39] report on measures that have been proven ineffective because too little attention had been paid to their practicability for major



**Table 2** Preconditions, costs and reverse effects

Preconditions (general)	Costs (specific)	Reverse effects (specific)
Availability	Financial / monetary cost	Displacement
Practicability	- Fixed	- Geographical
Required knowledge	- Variable	- Temporal
Required expertise	Ethical / social cost	- Target
User awareness	- Labelling / discrimination	- Tactical
User belief	- Distrust	- Crime type
User commitment	- Civil liberties	Escalating effects
Co-operation	- Inequalities	Creative adaptation
	Esthetical cost	Enticement effects

stakeholders, e.g. innovations that left senior citizens trapped inside a fortress of heavy doors and electronic card-key devices which they found difficult to understand and to operate, while neighbors were no longer able to keep a friendly eye on them. Other issues related to the practicability of preventive measures are highlighted in studies on property marking [40] and on schemes to defeat vandalism [8].

If a measure is unavailable (e.g. because local law does not permit its use or implementation), it simply cannot be introduced. If a measure is available to the end-user but its introduction would impact core business processes to an extent that their execution becomes extremely difficult or impossible, there is little guarantee for success. As Beck and Willis argue, there is a delicate balance to be struck between meeting security imperatives and maximizing business opportunities [41]. The same applies when the implementation of a certain measure requires a level of knowledge or expertise that is unavailable to or hard to obtain for the end-user. A poor understanding of available techniques to analyze the crime problem or to implement security measures and evaluate their effectiveness and efficiency may render all preventive efforts useless. As Knutsson and Clarke put it, 'seemingly simple measures can be rather difficult to implement for a variety of technical, managerial and social reasons' [42]. Whilst major international supply chain operators have staff employed with a vast experience in tackling transport crime, this is not always the case for small and midsized enterprises, and even less for the thousands of shippers who, under total supply chain security management, become involved in securing their goods and premises.

Other preconditions include the need for end-users to be aware of the problem that is being dealt with, to belief in the effectiveness of the proposed solution(s), and to be committed to solve the problem and to co-operate with other stakeholders to reach the desired outcome. Those who need to initiate action need to be aware of their responsibility to do so. They need to be committed to act, and to achieve the necessary coordination among all parties concerned. Especially the latter can prove to be quite challenging. Effective crime prevention is often about partnership, in that 'each of the players has a role which complements and must be coordinated with the others in a system of mutual co-operation' [43]. As illustrated by Newman and

Clarke in a case study of the reduction of credit card fraud, there are numerous cases where situational crime prevention has succeeded through forging partnerships among the crucial players [16], and the fact that a lack of commitment or co-operation causes preventive action not to reach its full potential is clearly illustrated in a study on ram raiding where it was discovered that police recording practices and a lack of commitment of some retailers made it difficult to collect useful data to tackle the problem [27]. As Tilley points out, 'competing demands on the organizations and individuals belonging to them; differences in philosophy, culture and organizational style; a lack of dedicated resources; differences over leadership; a historic lack of trust; an apparent indifference or apathy amongst some; and so on; all conspire to create obstacles to the operation of effective formal partnerships' [7].

A first set of cost components specifically relates to the introduction of a certain measure that is under consideration. This is the case for its *financial*, *ethical* and *esthetical costs*. As argued before, monetary costs cover the fixed and variable costs of investing in crime prevention. Social costs relate to the (perceived) impact of the introduction of a measure on civil liberties, convenience and conduct of staff, customers and other stakeholders; and esthetical costs relate to the (perceived) impact on the esthetics of the environment in which a measure is introduced.

Finally, another factor that requires careful consideration in order to come to an all encompassing cost assessment, is the impact of a range of unintended consequences that may come into effect following the introduction of a certain (set of) measure(s). As outlined in Table 2, this impact may result from *displacement*, *escalating*, *creative adaptation* and/or *enticement effects*.

### **A conceptual model for an ex ante consideration of preventive measures**

The standard methodology applied for designing situational projects is 'a version of the action research model in which researchers and practitioners work together to analyse and define the problem, to identify and try out possible solutions, to evaluate the result and, if necessary, to repeat the cycle until success is achieved' [8]. As such a generic situational crime prevention project comprises five stages: a collection of data about the nature and dimensions of the problem; an analysis of the situational conditions that permit or facilitate the commission of the crimes in question; a systematic study of possible means of blocking opportunities for these particular crimes; the implementation of the most promising, feasible and economic measures; and a (constant) monitoring of results and dissemination of experience [8].

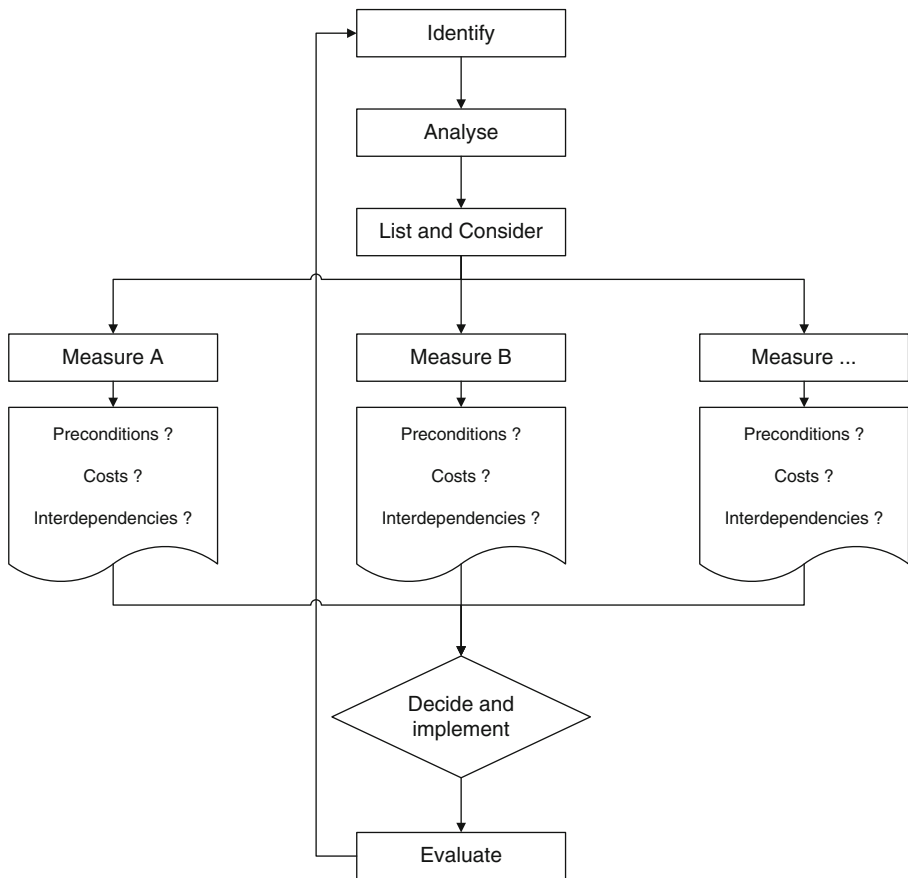
A proper identification and clear definition of the problem at hand is essential in order to make a statement on the urgency and priority to tackle it, as well as the decision on appropriate strategies to intervene. If the problem definition is wrong to start with or important information is overlooked, then the whole process (and consequent decisions) can be compromised [19]. Once the crime problem has been identified, defined and prioritised, it is essential to further analyse the situational conditions that permit or facilitate the commission of the crime(s) under study, and the situational context and environment in which preventive action is required. Consequently, an inventory of effective measures, whether the most appropriate or not, is to be produced. Each of these measures should be carefully scrutinized, and

potential interdependencies identified.<sup>7</sup> The outcome of this *ex ante* consideration can be applied to help prioritise and rank alternative interventions, and to decide on the most promising and feasible option(s). When the cost-benefit calculus for a certain (set of) measures turns out negative, alternative measures can be (re) considered. As outlined in Fig. 1, the actual implementation stage should only start when all potential measures have been identified and considered, and a detailed implementation plan allowing for constant monitoring and an ‘*ex post*’ impact and process evaluation has been agreed upon with users and other stakeholders. The latter may adopt a range of methods such as randomised control trials, simulations, examination of detailed expected outcome footprints and regression discontinuity designs; and may be conducted in the interest of informing policy decisions, to inform practitioners’ and policymakers’ decisions when faced with a new situation, and/or in the interest of taking a field of applied knowledge forward [44].

### Cost modelling

In this final section it is argued that management science and criminology can be of much assistance in enabling practitioners in industry to conduct a proper cost analysis and come to an informed decision on what particular measure(s) best to implement. Management science has traditionally been concerned with building explicit models for analysis and managerial decision making [45]. According to Moore and Weatherford [45], a ‘learning-from-modelling’ approach allows managers to address the most important issues of any decision-making situation, including the choice what alternative options to investigate and to implement. Models can be used to abstract the problematic aspects of a management situation, often involving conflicting or competing alternatives, into a quantitative model that represents the essence of the situation. As such, modelling can be of much assistance to those assessing the (benefits and) costs of alternative preventive measures. When having to decide on what measures to implement to prevent unauthorized access to the loading compartments of pick-up and delivery vehicles—a requirement that forms part of various anti-theft and anti-terrorism security programs—one could decide on fitting door alarms and GPS modules on all vehicles or, as a combined or alternative option, go for the human factor approach and decide to provide recurrent training to all drivers making them aware of the need to lock their vehicles at all times and check the loading compartment after having made any scheduled or unscheduled stops. For both options a number of cost factors can easily be translated in a deterministic model. This is the case for all aspects that are known with a reasonable amount of certainty (e.g. financial costs). These costs can be depicted in total or—at least the majority of them—divided over time costs and distance costs, a practice that is quite common in contemporary transport and logistics

<sup>7</sup> According to Clarke ‘a situational project is more effective when it adopts a package of measures, each of which is directed to a particular point of the process to committing the crime’. It goes without saying that each individual measure within this package should be carefully considered prior to its implementation, and any potential interdependencies should be recognized and overcome prior to the actual implementation.



**Fig. 1** Conceptual model

management [46].<sup>8</sup> The total monetary cost for the first option (i.e. the ‘technological’ approach) equals a range of fixed and variable costs including the purchase of the electronic devices, the installation and maintenance cost, the cost for internal or external monitoring of alarms and consequent interventions, and communication costs. For option 2 (i.e. the ‘human factor’ approach), fixed and variable monetary costs include the cost of providing trainers, training facilities and training material, the recurrent cost of replacing drivers who are participating in the training, etc.

The assessment of ethical and esthetical costs presents a challenge and requires a somewhat different approach. To a certain extent it remains a normative discussion, but, notwithstanding that, criminology and management science can provide tools that allow for incorporating the assessment into the decision making process on what measures best to implement. In the academic debate on the cost of crime, several methods have been proposed to estimate intangible or non-monetary costs such as those invoked by pain and suffering [47]. These include methodologies such as

<sup>8</sup> Time costs are imputed on the basis of the duration of a transportation movement, distance costs according to mileage (source: [46]: 73).

contingent valuation, which involves probing potential victims on how much they would be willing to pay in order to avoid the pain and suffering associated with a crime [48]; and the methodology applied by Von Hirsch and Jareborg [49] in an effort to categorize the harms of crime. The latter methodology focuses on assessing the impact of a crime on the victim's standard of living,<sup>9</sup> identifying four generic-interest dimensions upon which crime intrudes: physical integrity, material support and amenity, freedom from humiliation, and privacy or autonomy [49]. Where these methods prove to be effective in assessing the social cost of crime, they can obviously be adjusted and applied to assess the social (ethical) or esthetical cost of crime prevention. The relative importance that stakeholders (e.g. management, unions or staff members) attribute to ethical and esthetical cost components can be determined e.g. by means of stated preference research [50]. Although this research has been criticized as depicting behaviour which is hypothetical and not observed in reality [51], it allows for estimating attributes on which revealed preference data is not (yet) available.

An *ex ante* consideration of (the impact of) potential reverse effects is even more challenging as these effects will only present themselves after the measures have been in place for a certain period of time. Offenders confronted with vehicle alarms may turn their attention to other, unsecured, vehicles (target displacement), or try to gain access to the load in another way (tactical displacement), perhaps by means of excessive violence (escalating effects). As Hamilton-Smith argues, 'measuring displacement [...] is particularly difficult because attributing the occurrence or non-occurrence of one crime to the prevention of another is ostensibly a somewhat speculative pastime' [12]. This is not to say that displacement and other reverse effects are completely unpredictable. Analyzing all available information on (potential) offenders, victims and offense locations at the very outset of a project may provide useful input for modelling patterns of offending and for considering how they might be affected by the introduction of a given crime reduction measure [12]. One needs to identify what criminal opportunities are left unattended once a measure has been introduced, and try to anticipate how the offender might attempt to circumvent or counter that measure. Although it may be impossible to predict every possible permutation in offender behaviour, one should at least attempt to identify potential temporal, spatial, target, tactical and offence changes. In order to do so, reliable data is crucial. For that reason it is of extreme importance to constantly obtain, archive and analyse as much detail as possible on incidents that occur within the organisation or—in this case—within the supply chain.

Finally, apart from trying to predict (the impact of) unintended consequences of the introduction of crime prevention measures during the design phase of the program, it is also extremely important to be vigilant for their manifestation once the program is in place. Even if crime reduction measures do not lead to any reverse effects in the short term, the monitoring of crime patterns and trends may reveal more long term adaptations by offenders to blocked opportunities or illuminate the exploitation of new opportunities [12]. For that reason a built-in monitoring system is essential to the long term success of any program.

<sup>9</sup> Standard of living is defined as the economic means and non-economic capabilities for achieving a certain quality of life ([49]: 7–11).

## Conclusion

Post 9/11 we have witnessed the introduction and further strengthening of a range of trans-border security programs designed to protect international supply chains against acts of unlawful interference. Specific programs have been introduced for nearly all modes of transport, including air, road and maritime; and to a great extent they comprehend the introduction of situational crime prevention measures. In most instances, however, operators within the supply chain—being made responsible for the actual implementation—are left with limited guidance. In this paper it is argued that such lack of guidance may result in measures being introduced without taking full account of their potential consequences. It is argued that the cost of introducing preventive measures entails not only the financial or monetary costs associated with the implementation, but also a range of other cost factors such as ethical and esthetical costs, or consequential costs invoked by potential reverse effects coming into play once a measure is introduced. This paper further identifies a range of generic preconditions that need to be in place in order for the introduction of a measure to be feasible and successful. The latter relate to the availability and practicability of a measure that is under consideration, to the knowledge and expertise required to implement it, to the level of (user) belief in its effectiveness; and to the level of awareness and commitment of end-users and other stakeholders.

It is argued that the various cost components that have been identified, need to be assessed as part of an *ex ante* consideration of the various measures that are deemed effective to mitigate the problem on hand, as this consideration would enable policy makers and practitioners in industry to come to an informed decision of what particular measure(s) best to implement. Considering actual and potential costs can assist to help prioritize and rank potential interventions, and to decide on the most promising and feasible ones. When trying to incorporate this *ex ante* consideration into the standard methodology applied for designing situational projects [8], it would succeed the production of an initial inventory of effective measures, and precede the actual implementation phase [4].

It is further argued that criminology and management science can be of much benefit in enabling practitioners to conduct a proper cost analysis and come to an informed decision on what particular measure(s) best to implement. Deterministic cost models can be applied for those aspects that are known with a reasonable amount of certainty (e.g. financial costs). Ethical and esthetical costs can be determined by means of stated preference research, or by applying research methods that have been introduced to assess the (non-monetary) cost of crime; and consequential costs invoked by effects of displacement or other reverse effects can, at least to a certain extent, be predicted through analyzing all available information on (potential) offenders, victims and offense locations at the very outset of a project.

The value of considering preventive measures before they are actually implemented is an obvious one, as it avoids that time and resources would be wasted and negative side effects would come into effect. In order to enable this process, those responsible for implementing a program should be allowed a certain freedom of choice between alternative measures and approaches. The latter is currently the case for some but by far not all programs, and clearly constitutes an area for improvement.

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