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CONSTRUCTION SAFETY MOBILE KNOWLEDGE SHARING AMONG GENERATION Y

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Abstract
For many decades the construction accident rates are high in many places. Previous research study shows that many of these victims, who ultimately ended up with legal proceedings in Hong Kong were generation Y, i.e. people who were born between 1982 and 1995. These generations are also well known as www generations who are well-equipped with internet knowledge and frequent users of the internet. The popularity of other mobile devices such as iPhone and iPad also increases the Web 2.0 participants. Whilst traditional web users can only access the internet at home or in office via the heavy computer or notebook, generation Y can access the internet easily via mobile devices while they are travelling or waiting for their dinner. As previous research on construction safety mainly focused on the causes of construction accidents and compensation, few have studied the safety knowledge sharing by this particular generation. This paper reviews the construction accident statistics in Hong Kong and studies the motivation of Generation Y in sharing construction safety knowledge based on Prisoner's Dilemma. All in all, the study provides useful information to safety course providers and construction safety team in designing relevant courses.

Keywords: game theory, construction safety, information sharing, generation Y, mobile device

1. Introduction

The cyberspace interacts with urban space and disrupts and collapses conventional enclosures and boundaries. Places move from one to another as shared spheres of interactions becomes increasingly virtual than physical. Bodies which coordinate multiple tasks and conversations now oscillate between private and semi-private modes of communication (Enriquez 2011). Backed by the entire telecommunication industry, mobile internet combines two of the most important innovations in recent times, i.e. mobile phone and the internet. Mobile internet is one of the few technologies which come close to emulating the success of the fixed internet. Hence, it comes as no surprise when market research firms and analysts painted a rosy future for mobile internet (Jiang 2009). Mobile communications have played an influential part in media transformations over the past two decades, and are set for an even greater role (Gerard Goggin 2008). The Mobile Access 2010 Report shows that

two in five adults use the e-mail, internet, instant messaging devices using a mobile device, which has grown by 40% from 32% in 2009. The use of non voice applications for mobile devices has increased significantly in recent years, especially among young adults between 30 to 49 year olds. 95% of cell phone owning 18–29 year olds use text-messaging and young adults in general are significantly more likely to use their cell phones for other mobile data applications, such as taking pictures, sending e-mail or accessing the Internet (Barnhart and Pierce 2012). Current understanding of mobile services is widespread and variable. It denotes a wide array of functionalities, including multimedia mail, portable recordings, mobile broadcasts, sponsorships, telemarketing, marketing, shopping, navigating (Rudolph and Emrich 2009). Nevertheless, its application in construction safety knowledge sharing is limited, not to mention the study in relation to game theory among generation Y. This paper firstly reviews the costs of construction accidents and accidents rates on sites among generation Y. Afterwards, mobile safety knowledge sharing on sites will be studied. Lastly, it sheds light on game theory and mobile construction safety knowledge sharing.

2. Costs of construction accidents and compensation among generation Y

Construction accidents happen on sites can lead to high compensation (Li and Poon 2009). In Hong Kong, the monetary compensation was highest in 2006, reached the amount of HK$39,643,353 and the lowest recorded in 2004 with HK$10,997,637 (Li and Poon 2009). Construction work may also be delayed due to lose in manpower for insurmountable paper work submission and case reporting to many government departments and insurance companies. Some works have to be stopped until the accident investigation is completed. Workers' safety is a complex issue. The poor workforce safety behaviors and attitudes, outdoor operations and fast changing design, coupled with complex equipments and tools on sites increase the difficulty in assuring people to work safely. Others victims may come across accidents because of lack of relevant information about the potential hazards on sites (Li and Poon 2009). Moreover, construction personnel spend much of their time working in a mobile mode: construction work does not take place in the site office but at the multiple work faces around a building site. Safety information on sites at different stages, safety planning, management and records, however, is usually kept in the site office. Various points of work are therefore isolated from many site safety information and knowledge (Er 2011, forthcoming). Many construction accidents happen because of lacking safety information. Generation Y, the green leaf on sites, who usually lack of experiences and knowledge, may easily becomes victims on sites.

Generation Y sometimes are also known as Generation Why, Echo Boomers, Generation Next and the Millennium Generation (Macky, Gardner, and Forsyth 2008; Martin 2005). People in this generation group share the same significant life events at critical developmental stages, such as witnessing the 911 events (Cennamo and Gardner 2008). They grow up in a media and technological-saturated World than their parents (Wuest et al. 2008; Yerbury 2010): it is also a generation where internet consumption exceeds television consumption (Reisenwitz and Iyer 2009). They share some similar characters as well. They are team players who perform well in collaborative work environments (Macky, Gardner, and Forsyth 2008; Martin 2005) and refuses to follow traditional standards blindly (Dwyer 2009). They may prefer a psychological contract with the organization, emphasis on social involvement and freedom (Cennamo and Gardner 2008). Previous court case findings reviews that those who ended up with legal proceedings were new comers on sites with shallow experience -- generation Y. (Although there is no precise parameters which pinned down the exact birth years of generation Y (Lower and Schwarz 2008), we simply identify generation Y as those who were born between 1980 and 1995 in this study) (Li and Poon 2009).

Table 1. Number of employees in construction sector who came across accidents in 2004 to 2007

Age group	Number of employees in construction sector by age group (2004-2007) (Census and Statistics Department 2009)	Number of court cases (2004-2008)	Percentage of court cases over construction employees by age group (10-3)
17 - 26	111.8	7	6.26
27 - 36	245.1	30	0.12
37 - 46	342.4	13	3.8
47 - 56	308.8	18	5.83
57 and above	61.4	15	0.24
Unknown	N/A	7	N/A
Total	1070.4	101	0.052

(Li and Poon, 2009)

Table 2. Monetary sum of compensation among employees from 2004 to 2008

Year	Total number of non-fatal accidents	Total PSLA ('000)	Total loss of earning ('000)	Total loss of earning capacity ('000)	Total Special damages ('000)	Total Future treatment ('000)	Total Deductions from ECC and victims' faults ('000)	Total sum of compensation ('000)
2008	29	6,779	26,964	267	610	584	4,005	32,443
2007	16	3,400	13,980	950	530	279	890	15,937
2006	19	7,260	20,234	875	1,378	2,669	7,640	39,643
2005	23	6,085	24,645	2,404	506	382	7,771	25,725
2004	14	2,940	11,283	431	211	116	5,174	10,998

(Li and Poon, 2009)

3. Mobile construction information and safety sharing on sites

In the world of asymmetric information, market participants possess unequal sets of information. Information has to be transmitted from information holder to a receiver. Sometimes, costs have to be paid from information transmitter, e.g. information post by mail. Therefore, information is often kept among the holders who may have no use for it but fail to transmit it to individuals who wish to receive it (Li 2011). Nevertheless, the success of a construction project relies on available and accessible information. Construction safety information is one of the typical examples (Er 2011, forthcoming).

There are many reasons or factors which lead to information clogged. Failures to transmit timely construction safety information are generally the result of:

1) Knowledge holders unwilling to share their information;

2) Lack of communication channels;

3) Many construction personnel on sites have to move around, such as foreman, site engineers and project managers. Some of them even need to change their working sites daily.

There is no doubt that it is hard to solve problem 1. Nevertheless, it is relatively easy to solve problem 2 and 3 nowadays. Advances in communication and computation technologies broadening opportunities for an increasingly innovative and flexible forms of learning(Misra 2012). allow us to access computer networks via mobile personalized devices (Chehadeh, Hurson, and Kavehrad 1999), such as mobile phones (iPhone, Android and iPad), wireless-LAN-enabled PDAs where people can leave their message to the others (Farley and Capp 2005). Besides, multi-databases offer an excellent channel to share safety information from multiple heterogeneous databases (Chehadeh, Hurson, and Kavehrad 1999). More importantly, our generation Y spend more time in our World Wide Web and they are more familiar with the latest technologies than the previous generation, sharing information via network in mobile devices are not stranger to them. For those who are addict to computer games, safety apps designed specifically for this group of people in also viable. Alternatively, they may learn some safety information via an interesting game, reading e-books via apps available in iPads which substantially reduce the heavy weights of carrying all the thick books where keywords search is also possible. In spite of the abovementioned convenience, there are limitations in our mobile technologies. Many information sharing approaches rely on mapping information from various different sources where different input requirements and output formats (Chen and Kaza 2008), for example, some of the older generation of Nokia mobile phone may not have the capability to connect to those iPhone Apps.

One of the very useful technologies which may be able to use on sites is WhatsApp. WhatsApp Messenger is a cross-platform mobile messaging application which allows us to exchange message via iPhone, BlackBerry, Android or Nokia mobile phone. WhatsApp Messenger utilizes the same internet data plan which we use for web browsing and email, there is no cost when we use it to send message to friends. Furthermore, it allows us to chat as a group, say 4 or 5 people at the same time. Each of the typed conservation can be seen by the others in the same group chat (see the figure below). When typed information is not clear enough, WhatsApp users can also send audio and video media messages to contact people in other part of the globe (Whatsapp 2011). On the other hand, for those who do not use smart phone, they can use iPad as a media of communication. With just a few taps in FaceTime, user can can see their friends and colleagues while they are talking to them (Apple 2011) which is similar to video conferencing in notebook or laptop computer nowadays.

Figure 1.The interface of the mobile phone group chat via Whatsapps

(Whatsapp 2011)

Some of the construction safety personnel have already identified this as a new way to share safety knowledge. In Korea, for example, short message service (SMS) software was developed to interpret and use the signal sent to manage safety on sites. The software consists of functions to input the location where the device was installed, and the name, contact information and responsibilities of each supervisor. There are ID codes for the devices and the manager can identify their locations by codes that were installed around the construction site. Authority in each location and safety officers who are responsible and the supervisor are able to obtain the information as short text via mobile phone, with detailed data being accumulated in the main computer in case of emergency (Lee et al. 2009). Another example, also comes from Korea, the mobile safety system is made up of the implemented mobile screen outputs of risk update interface (RUI) and take operation interface (TOI) of the prototype SMVS. It consists of location matching in the left screen, the risk registration process using RUI in the middle and shows the TOI screen showing augmented safety information after registration on the right side. A question and answer game (QAG) has been designed for safety education on sites. Workers get access to the game using worker or company and then the user identification interface automatically displays the necessary safety education game related to his work activity. The QAG was developed and tested, with which worker navigates his virtual job site by controlling with keyboard, joystick or mouse. Workers have to select a what-to-do for the risk situation among multiple choice safety measures. If the answers are correct, the system calculates the score of the correct answer. The system displays relative information about opening related accident cases as well as right preventive measures if the worker chooses a wrong answer so as to improve workers' risk cognition. Nevertheless, some of the interviewees also raised the problem that they were unfamiliar with 3D information and it is difficult to control the user's movement and view. Furthermore, to operate the system, time, information and temporary facility need to be integrated (Park and Kim 2012, Forthcoming). In the US, Irizarry and Gill (2009) developed two mobile applications based on the situation awareness approach. The first system, Construction Equipment Finder searches for the closest piece of equipment based on the user's location. The second system, Be Safe displays safety-related information in an iPhone application (Nourbakhsh et al. 2012). There is no doubt that the abovementioned examples show that construction safety knowledge sharing have turned into a new page: mobile era.

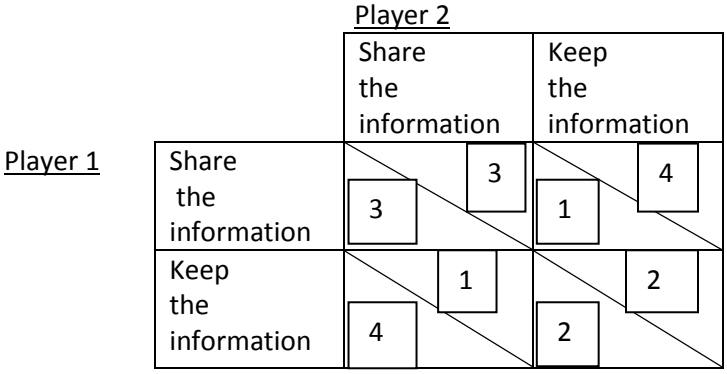
4. Game theory

There are many different schools of thoughts which analyse people's strategies or motives. Game theory is one of the most popular branches in economics field which is used to study people's strategies and behaviors. In fact, cconsiderable effort has been devoted to applying game-theoretic techniques in industrial economics since 1970s (Li 2011). As one makes the choice to cooperate entails a sacrifice, i.e. they all help others with cost (Doebeli and Hauert 2005), e.g. time cost for sending the message. Many economists study the relevant strategy on the first-mover, motivation to share the information and reputation formation in case of cooperative. Nash strategies, for example, are famous in rationalizing firms' behavior in an easy way. Despite its popularity, there is also criticism about game theories, for example, some may criticize that our decision-makers are far less analytic than these models posit and the unrealistic of 2 players in the games (Li 2011). In the following sections, the author will discuss the mobile safety knowledge sharing via one of the most popular game theories: Prisoner's dilemma and its repeated form.

4.1 Prisoner's Dilemma

In spite of some of inherent problems in the models itself, it can generate some useful explanation in human behaviors. Among all the game theory models, Prisoner's dilemma is selected to illustrate the motives of construction safety information sharing. It is one of the most well-known symmetric 2×2 games (Duffy and Feltovich 2006). The idea of Prisoner's dilemma originated from 2 prisoners in a prison and were questioned in 2 separate rooms (Li and Poon 2011). The dilemma models a situation where there are gains in cooperation but each of the participants also have an incentive to free-ride (Osborne 2004). The model also provides great explanation in collective action. Sometimes, it has been used in public good problem or others to check participants' strategic structure (Snidal 1985). The following figure illustrates typical payoffs in case of Prisoner's Dilemma. For simplicity, two-person model will be used for discussion here. In case one of the player decline to share the safety knowledge via mobile devices but the other share the information, the one who withhold the information receives the higher value in return (1,4) or (4,1). Nevertheless, if two of the players withhold the knowledge, both of them receive a lower value than both of them cooperate (Yi, Johnson, and Bickel 2005). Therefore, there is a tendency to cooperate under the Prisoner's Dilemma.

Figure 2. Information sharing game between knowledge holder and receiver



(Yi, Johnson, and Bickel 2005)

4.2 Repeated games in Prisoner's Dilemma

Decision making on whether or not to share the safety information among the construction personnel is not an one-off but repeated activities. Construction personnel may choose to corporate (C), i.e. share their safety knowledge or defect (D), i.e. hold their knowledge each time in each period. Their decisions in each stage rely much from the past experience. For example, in time period t-2 (**Error! Reference source not found.**), two players choose to cooperate, each of them share some of the safety information. They find it useful to share information to the other as they will receive something new in return. Nevertheless, if one of them share his information at stage 2, time period t-1 but finds that his partner does not share his information in t-1, the payoff of the defect one may be higher (as he free rides and share information involves some costs) at one particular stage. When it goes to time t and t+1, both of them may choose not to share information anymore (In 1950, John Nash and his students found that 25 plays of repeated games is not enough to stablise the subjects' behaviours, the 4-column table here only shows the simplify version of the case). This also implies that the safety information pie will shrink finally if everybody do the same (Osborne 2004). From this perspective, mobile device only provide a useful channel to share safety information, however, its success relies heavily on the some forces which motivate people to share information, instead of free riding, waiting information to goes into their chat boxes.

Table 3. Strategy of the safety information holders and their payoffs

Period	t-2	t-1	t	t+1
Player 1	C	C	D	D
Payoff difference	||	<	=	=
Player 2	C	D	D	D

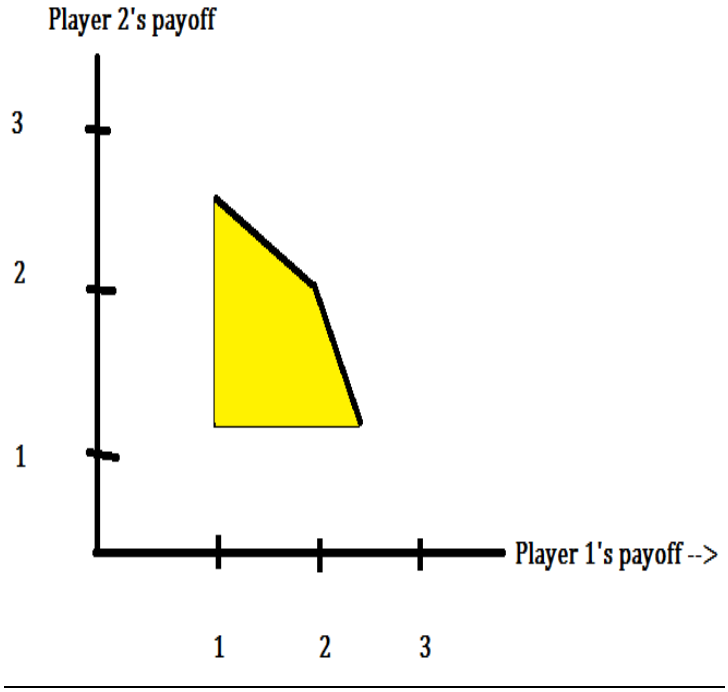
(Osborne 2004)

As rational human beings prefers to enjoy something at the present moment and anything receive in the future will be of lower value, the total amount we receive in the future has to be discounted with the calculated risk free rate. According to Osborne (2004), individual's decision makings on information sharing depends on the discounted sum of outcomes in the repeated games. Suppose each player I has a payoff function p_i and a discount factor of σ_i between 0 and 1, such that when he evaluates the sequence of the game in different period ($s^1, s^1, \ldots, s^T$). The discounted payoff of the will be equal to:

$$\mathrm{pi}(s^1) + \sigma\mathrm{i}\,\mathrm{pi}(s^2) + \sigma_i^2\,\mathrm{pi}(s^3) + \cdots + \sigma_i^{t-1}\mathrm{pi}(s^t) = \sum_{t=1}^{t} \sigma_i^{t-1}\mathrm{pi}(s^t)$$

What is the ideal discount factor then? Previous study shows that under the Prisoner's Dilemma situation, discount factor is close to 1. The figure below illustrates the approximate set of Nash Equilibrium payoffs for the repeated Prisoner's Dilemma when the discount factor is close to 1.

Figure 3. Nash Equilibrium payoffs for the repeated Prisoner's Dilemma when the discount factor is close to 1



(Osborne 2004)

5. Conclusions

Technological breakthrough nowadays changes everybody's life. The popularity in mobile device, such as iPhone, iPads, Smart phones etc usage not only brings us convenience in daily communication, it also provides us an alternative way to transmit timely information on sites among Generation Y. With the help of mobile device, they can receive update safety information from those in site office. Finally, the Prisoner's dilemma illustrates that individual's decision makings also depend on the other participants as well as the importance of cooperate. If everybody free rides, it may finally lead to a safety knowledge sharing system breakdown ultimately. This is also reflected in case of the repeated games where individual's decision makings on knowledge sharing depend on the discounted sum of outcomes in the repeated games.

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