SHIELDING WORKERS FROM HEAT STRESS: RECONCILING THE PARADOXES OF PROTECTION AND PRODUCTION LOGICS

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Safety and productivity are often perceived as competing demands in a construction project organisation and the strategies of achieving them as a dilemma for project decision-making. We explore the safety-productivity paradox through an institutional logics lens. Through an in-depth single case study of climatic heat stress management in a subcontractor's project organisation under a mega-project in north Australia, the manifestations, consequences and interrelations of three institutional logics of processing safety in production are explored: the protection logic, the production logic and the reconciling logic. The results illustrate the paradoxical effects of the protection logic and the production logic and the emergence of a reconciling logic leading to innovation that improves both safety and productivity. However the reconciling logic is missing at senior and middle management levels of the production side of the organisation, and overwhelmed by the strong production logic. It is concluded that the reconciling logic can be further established and endorsed through adjusting the structure and modification of the production and human resource management system.

Keywords: Australia, climatic heat stress, construction safety, productivity, institutional logics

INTRODUCTION

Safety and productivity are often perceived as competing demands in a construction project organisation and the strategies of achieving them as a management paradox (Lewis and Smith, 2014) which is to be solved through conscious balance in senior management decisions (Smith and Lewis, 2011). However, questions as why members of an organisation are collectively blinded to one issue or another, why efforts of balancing goals do not necessarily lead to effective mitigation of risks, why actors in the system are bounded to an either-or repertoire of coping strategies, and what leads to reconciliation of safety and productivity in construction, remain unanswered. We seek to explain these issues through an institutional logics perspective and identify the manifestation of a reconciliation logic through the investigation of managing climatic heat stress risks on an Australian construction site.

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Climatic heat stress risk is a challenge to both safety and productivity on construction projects for its physiological effect on declining physical capacity and mental alertness (Parsons, 2014), leading to declining productivity or heat illness or accidents on site. Recent research reported an annual labour productivity loss of AU$6 billion in Australia due to climatic heat stress (Zander *et al*., 2015). However, despite readily available guidelines to manage it (e.g., AIOH, 2013), the Australian construction industry is surprisingly ignorant to this issue and there has been very little research in this area to inform project management strategies. We address this gap and, through investigation of its management on site, identify factors constituting a logic that reconciles safety and productivity in a project organisation.

Institutional logic is the underlined reasoning schemas that provide meaning, connection, justification and consistency to the practice and discourse of organisational and individual actions (Thornton *et al*., 2013, Thornton and Ocasio, 2008). It focuses actors' attention around some problems (and therefore blinds them from the rest), determines how the actors collectively define the problems that are worth attention, and pre-defines a repertoire of solutions (Thornton, 2001, Thornton, 2004). Concerning how safety is processed in the production system of construction projects, Jia *et al.,* (2015) explicated two organisational level institutional logics that underpin actors' cognitions and actions: a protection logic and a production logic. The protection logic assumes safety and work are mutually exclusive and workers' welfare is to be achieved through sacrificing productivity. Such logic was seen in developing countries where construction sites have not yet established a safety management infrastructure. In the developed countries such as the Australian context, this logic remains underpinning the discourses and actions of certain stakeholder's groups, such as the workers' unions.

The production logic assumes production is the business of a construction project while safety is an institutional burden that needs to be cleared up with minimum attention. Such logic was seen in societies where formal institutions and regulators actively control the OHS responsibility of employers while employers strive for production to survive the market. Both logics assume a dialectic between safety and productivity, bounding project teams in an 'either-or' dilemma that demands actors' decision of selection or prioritisation, yielding paradoxical outcomes. Solution to such paradoxes involve a shift from 'either-or' to 'both-and' cognitive frame and a strategic focus on innovation (Smith and Tushman, 2005) that draws inspiration from the redefined problem 'how to do the work safely and productively', seeing safety as an attribute of the production system that indicates its fitness-to-operate (Griffin *et al*., 2014). We define such an institution-making logic that assumes an integrated safety-productivity premise in an organisation as a reconciliation logic. An organisation accommodates multiple logics (Besharov and Smith, 2014). The three institutional logics coexist and compete in a construction project organisation and their manifestation. One can prevail at certain stage of a project (e.g., the production logic often prevails when the project is behind schedule) or upheld by certain groups of stakeholders in the project.

An institutional logic is to be differentiated from a strategic decision made by an organisational leader (Smith, 2014) in that institutional logic is socially and collectively constructed by all levels of actors and the structures of organising them, thus has a more effective influence on the outcome, while the latter is one of the factors that constitute the former and can be distorted when the middle management and frontline personnel are exercising a different logic (Durand *et al*., 2013).

Different from an organisational strategy in the form of organisational policy or senior management decisions, institutional logic is constituted by policies, regulations, management infrastructures, rules, norms, and established practices in the institutional environment throughout a project organisation. Recently, paradox theorists shift their search of solutions from senior management decisions to the multiplicity of institutional logics within an organisation (Besharov and Smith, 2014). The aim of this study is to explore the manifestation and consequences of the multiple institutional logics of processing safety in production and, in particular, the presence and absence of the reconciliation logic at different levels of a construction project organisation that helps to solve the safety-productivity paradox.

METHODOLOGY

The empirical research was conducted with a single case study approach using a triangulated data collection strategy from three major data sources: on-site ethnographic data, documents, meteorological data and off-site interviews.

Data collection

The selected case was a subcontractor's project organisation in a mega-project. The project was the construction of oil and gas on-shore processing facilities, located in North Territory of Australia, a climate zone of hot and humid weather. The project started in 2009, valued AU$34 billion, and is expected to complete in 2020. In total there were around 8,000 workers working on site every day.

The sub-contractor's company had around 22,000 staff and an annual avenue of 1.4 billion Euro in 2015. In this specific project, the subcontractor was working on the scaffolding work with a main workforce of 120 scaffolders. Four supervisors rotated to maintain the presence of three on site. Each of the three teams was divided into four groups of ten, headed by a Leading Hand (workers' leader). In the site office was the project management team, including senior management team (Project Director, Project Manager, HSES Manager, Construction Manager, Commercial Manager, HR Manager, Estimation Manager, Engineering Manager, etc.), HSE advisors, engineers, supervisors and administration staff.

The main data source was ethnographic data collected on site over a working week in late September 2015. One of the research team members was the Health, Safety, Environment and Security (HSES) Manager of the subcontractor's organisation. He acted as a gatekeeper and an informant for another academic researcher to come on site for a rapid ethnography (Pink *et al.*, 2013, Loosemore *et al.*, 2015). The rapid ethnography was guided by a central interest of understanding the organisational structure, safety, procurement and human resource management system, production work flow as the institutional context of heat stress management practice. The collected data included field notes of participant observation (Goffman, 1989), informal focus groups with three scaffolders' groups and one riggers group working in material storage yard, and 22 informal interviews (interviewees included a quality manager, a commercial manager, HSES manager, two safety advisors, a safety and environment advisor, senior safety advisor, HR administrator, engineer, two site supervisors, a procurement administrator, a lean construction advisor, a safety campaign coordinator, and eight scaffolders). In addition, documents related to this project were collected, including project meeting minutes and policy statements, project Enterprise Bargaining Agreements (EBA), heat stress policy by Construction Forestry Mining and Energy Union (CFMEU), company and project profiles. Finally, heat stress data including temperature, humidity, wind speed and solar radiant heat were recorded at one-minute interval; meteorological data were obtained from the nearest observatory station.

Measurement of heat stress

Climatic heat stress is composed of four factors: temperature, humidity, radiant heat and wind speed. These four factors can be synthesized into one single index, the Wet Bulb Globe Temperature (WBGT), to give a realistic measurement of the 'hotness' of the environment (Rowlinson *et al*., 2014, Parsons, 2006). Air temperature is often taken for granted by the general public as a single indicator of heat stress, and is used in many empirical guidelines that are lack of a research base, such as the CFMEU heat stress policy analysed in this study (CFMEU QLD NT, 2015). The problem with single-indicator measurement is that they do not necessarily reflect the heat stress level of workplace, thus lead to either unnecessary productivity loss or unmitigated risks. Apart from the climatic heat, the metabolic heat generated by physical activities contributes a significant amount of heat stress on human body. In the construction work setting, metabolic heat is determined by workload, work pace and continuous working time (Rowlinson *et al*., 2014), which are linked to both formal and informal aspects of management and supervision. Moreover, whether or not heat illness occurs to a person in a hot environment is contingent on many individual factors such as hydration status, fatigue and psychological stress (Jia *et al*., 2016).

Productivity analysis

Productivity can be measured by labour productivity, capital productivity, multi-factor productivity or total-factor productivity (Loosemore, 2014). In this study we analysed labour productivity against two threshold-based heat stress guidelines, the temperature-based CFMEU heat stress policy as a manifestation of the protection logic, and the WBGT-based, scientifically developed guidelines by American Conference of Governmental and Industrial Hygienists (ACGIH, 2014) as a benchmark of the actual effect of heat stress. The quantified productivity analyses results were used as triangulation to the interview and observation data, the former used under the protection logic and the latter under a reconciling logic.

The CFMEU policy specifies a set of thresholds linked with actions of reducing daily working hours or increasing breaks. This formal institution was used as a materialisation of the protection logic, examined against the 2015 meteorological data to estimate the annual productivity loss assuming a situation if it was literally implemented. The WBGT-based thresholds for moderate level of physical work specified by ACGIH (2014: 215) were used for estimating the productivity effect of a safety initiative of shading the workplace: The direct effect of a shade is to block the solar radiant heat, thus reducing the overall heat stress. We used our on-site heat stress data recorded at one-minute interval in the material storage yard on 30 September 2015 as a sample to calculate the productivity levels with and without the radiant heat. The threshold systems specified in the two guidelines can be seen in Table 1.

Synthesis and validation

The different data sources were triangulated to construct an authentic case of site practices in relation to the management of heat stress. The factual data were then crosschecked with the HSES Manager in the research team. The authenticated case was then coded with the Six-C coding scheme, i.e., cause, consequence, condition, covariance, context, and contingent (Glaser, 1978: 74), centred on the three institutional logics.

Table 1. Work-rest regimens in two heat stress guidelines for productivity analysis

CFMEU heat stress policy		ACGIH heat stress guidelines	
Daily maximum temperature	Suggested rest period	Hourly average	Suggested workload
Over 30°C	*Keep an 8-hour working day*	28°C-WBGT	75-100% work
30 to 32°C	10 Minutes/Hour	29°C-WBGT	50-75% work
32 to 35°C	15 Minutes/Hour	30°C-WBGT	25-50% work
More than 35°C	At least 30 Minutes/Hour	31.5°C-WBGT	0-25% work

The coding results were clustered and organised into episodes to illustrate the institutional logics. The results of the study were validated by referring back to the actors, including a follow-up interview with two union leaders off-site and written and verbal communication with the project management team.

FINDINGS

The paradoxical effects of the protection and production logics

- *Paradox 1: A strong protection logic leads to exposure to risks*

Underpinned by a logic of protecting workers' financial interests, the enterprise bargaining agreement (EBA), negotiated between the unions and the employer specified a 58 hour working week, which demanded 10 hours' work on a weekday and 8 hours' work on Saturday. The long working hours did secure workers a higher daily wage than the industry average, however, taking into account of three hours' daily travelling time, workers were inevitably exposed to a major risk of fatigue, a precursor of heat illness and other accidents.

In the same protection logic, the CFMEU heat stress policy suggesting a work-rest regimen based on daily maximum temperature. Table 1 presents the analysis results of its productivity impact using Darwin's 2015 meteorological data. If this policy had been enforced, the foreseeable productivity reduction would be 24.6%. With the workforce of 120 scaffolders, subcontractor's project organisation would expect 102,160 working hours' loss a year. This foreseeable productivity loss is obviously unaffordable for a project organisation. Moreover, in the Australian social context, a specific worry of the employer was that workers might take advantage of the rest period duration, leading to even greater loss in productivity (M01, M03). As a matter of fact, the policy was ignored in practice. The climatic heat remained a risk on site.

Table 2. Estimated 2015 labour productivity loss according to CFMEU heat stress policy

Daily maximum temperature	Suggested rest period	Affected work days	Foreseeable lost working hours (per worker)
Over 30°C	*Keep an 8-hour working day*	*212*	*424*
30 to 32°C	10 Minutes/Hour	127	169
32 to 35°C	15 Minutes/Hour	127	254
More than 35°C	At least 30 Minutes/Hour	1	4
Total lost work hours (120 scaffolders)			102,160
Estimated productivity loss			24.7%

- *Paradox 2: A strong production logic leads to productivity loss*

Driven by a production logic, project planning and supervision were blinded to the risk of heat stress in hot weather. By the physiological law, there is a natural declination in the maximum physical capacity in heat. Such a phenomenon was mentioned by a workers' leader,

- In such a hot weather, even we don't get heat illness, there is a plateau in our physical capacity. We certainly get physical exhaustion.

Such a phenomenon, however, did not come to supervisors' attention. After all, his accountability was to deliver the project! When asked if there were any heat stress risk among his workers, a supervisor answered,

- No. We don't have such issue. Some can become grumpy in hot weather, but it's just a matter of personality. That's the nature of the work. You got to work with the environment.

However, a heat exhaustion incident was observed in his team five minutes after his statement: A sleepy worker tried to improve his concentration by drinking a strong coffee, which further dehydrated him. His limbs were out of coordination at 11.30 am. He had to take a long break for recovery. The team suffered from a low morale which further lowered the productivity. Supervisor's ignorance to the heat risk was manifested in the unchanged productivity expectation, leading to progress pressure on workers. When asked why they were relatively safe in the other working days but had a heat illness case on this day, a worker mentioned the impact of a progress pressure on the work pace,

- We normally can work slowly to be safe. But today's work is very important. Everybody worked very fast.

Supervisors' ignorance of heat stress and pushing for production triggered workers' cynicism. This was heard from a worker's summary of the incident,

- Supervisors don't care unless they work someone into serious illness.

In another interview, a worker compared his current job with his previous ones, "In the city you had to work very fast. Here you don't work hard." "Why?" He was twinkling his eyes, "Because you DON'T." The results show that managers chose to ignore the heat risks on site for worries of productivity losses and employee exploitation of rest period duration, which, ironically, resulted in heat illness cases which cost productivity. Moreover, the occurrence of such incidents triggered workers' cynicism and low morale, and activated the protection logic, leading to further productivity losses.

Emergence and absence of a reconciling logic

Actions indicating a reconciling logic between safety and productivity were identified in the bottom-up efforts of a safety programme. Initiated by the principal contractor and funded by the client, all subcontractors of the project were required to participate in a behavioural safety programme named Incident Injury Free (IIF). The IIF programme aimed at promoting safety behaviours through training, coaching, visible safety leadership, facilities improvement and social support. The subcontractor set up a committee for IIF, led by the Secretary to the Project Manager, attended by members from all levels of the project team. The safety initiatives can be either top-down, from the principal contractor, or bottom-up, proposed by the subcontractor's IIF action team and funded by the client. In observation, the bottom-up initiatives were more effective. Related to heat stress, ice-making machines were provided in the office area and in an on-site crew area. Each worker was provided a thermo-insulated water jar to make it easier for working at different locations of the site. Once a month, the Action Team made a walk around the site to search out their workers from every corner of the site to distribute ice cream (hydration icy poles). The ice-cream walk was more symbolic than problem solving, but effectively created a sense of community and a culture of caring among the workers. The action thus brought an effect of breaking the protection logic.

Another safety initiative by the IIF team was to build a canopy in the material storage yard. We compared the heat-affected productivity between working in an open yard exposing to radiant heat and in a shaded yard without extra radiant heat, using the WBGT-based thresholds in the ACGIH guidelines as a benchmark. As can be seen in Table 3, by shading the workplace, the overall labour productivity can be improved by 30%.

Table 3. Productivity result of a canopy in the yard

Time (hour)	Heat stress in the open yard (with radiation)	Heat stress in shaded yard (without extra radiation)	Productivity in open yard (hour)	Productivity in shaded yard (hour)
0900	27.1 ºC-WBGT	25.9 ºC-WBGT	1.00	1.00
1000	29.6 ºC-WBGT	27.4 ºC-WBGT	0.70	1.00
1100	30.7 ºC-WBGT	28.4 ºC-WBGT	0.40	0.50
1200	31.8 ºC-WBGT	29.1 ºC-WBGT	0.25	0.75
1300	31.5 ºC-WBGT	29.1 ºC-WBGT	0.25	0.75
1400	32.1 ºC-WBGT	29.5 ºC-WBGT	0.15	0.50
Total effective productivity (hours/percentage)			2.8 (60%)	4.5 (90%)
Productivity improvement by shading the yard				30%

The emerging logic constituted by the bottom-up initiatives was found to be incomplete and handicapped when examining the actions at multi-levels of the project organisation. The organisational chart of the IIF team indicated a lack of involvement from the production side of the organisation. Departments such as human resource management, engineering, project scheduling, or procurement department, were absent from the team. Managers of these important departments were treated as individuals looking after their personal safety at work, rather than as designers and controllers of the management systems that could have contributed to the improvement of workers' safety on site. An example was seen in the commercial manager's personal safety commitment statement, who promised that he would "*get up from my desk stretch/walk about to manage posture*" and "*tidy my desk at least once a week to promote housekeeping*".

Whilst such a safety commitment did fit into the IIF advocacy of 'safety leadership' where leaders were encouraged to demonstrate safety behaviour to the workers, the kind of behavioural safety is however irrelevant to his job role. An important factor that led to fluctuated workload among the scaffolders was the errors in material procurement and provision, which resulted in a pattern that workers were either idling to wait for the right gears or rushing to meet the deadlines when they finally arrived. Had the project procurement procedure been set up to be responsive to site safety, the commercial manager would have seen the opportunity of making strategic adjustment that could lead to improvement in both safety and efficiency at work. The reconciling logic was missing at this part of the organisation, and is inconsistent to the actions of the IIF team.

DISCUSSION

Findings of this study demonstrate the paradoxical consequences of the protection and production logics of processing safety in production, and identify an emerging but incomplete reconciling logic. The propositions of safety and productivity of the three logics can be summarised in Table 4. The protection logic underpinning the rules and policies for protection of workers' interests, manifested in the long working hours specified by the EBA and the unrealistic heat stress policy by the union, paradoxically led to a consequence of more safety risks to the workers. On the other hand, contractors were stuck in the production logic, tried to push productivity by an exclusive focus on production, ignoring the heat risks, which paradoxically led to incidents and low morale, leading to productivity loss. The bottom-up safety initiatives under the IIF programme, as interpreted in action by a devoted action team, worked as a seed of the growing reconciliation logic. However, the strong protection and production logics were enhancing and activating each other thus downplaying the emerging reconciliation logic. In the absence of such efforts at the senior management level and the production side of the organisation, the reconciliation logic is incomplete and handicapped.

Table 4. Safety and productivity in different logics

		Protection logic	Production logic	Reconciliation logic
Safety	What is it	Workers' welfare; Fight against employer	Clearing trouble from union and regulators	Safe work
	Whose responsibility	Employer	Workers	Myself
	How to achieve	Stop work	Safety behaviour	Effort by all levels
Productivity	What is it	Employer's worry	Core interest	Smart work
	Whose responsibility	Employer	Workers	Both
	How to achieve	None of our business	Make workers work	Innovate

CONCLUSIONS

The aim of this paper was to explore the manifestation and consequences of the multiple institutional logics of processing safety in production and, in particular, the presence and absence of the reconciliation logic at different levels of a construction project organisation. Through an in-depth case study of heat stress management in a project organisation in Australia, we explored the paradoxical effects out of the protection logic and the production logic. Meanwhile, the emergence of a reconciling logic was identified in the bottom-up safety initiatives, but found to be incomplete due to the lack of involvement at senior and middle management levels on the production side of the project. The findings highlight the need of involvement from actors on the production side of construction projects for building up the reconciling logic to solve the safety-productivity paradox. Theoretically, the study contributes to the understanding of logics multiplicity in addressing organizational paradoxes.

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